ECONOMIC AND BENEFITS ANALYSIS OF

THE FINAL 2013 VESSEL GENERAL PERMIT (VGP)

Office of Wastewater Management

U.S. Environmental Protection Agency

March 28, 2013

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Abbreviations and Acronyms

ACSI	Alaska Cruise Ship Initiative
ADEC	Alaska Department of Environmental Conservation
AFFF	Aqueous film-forming foam
AMSA	Australian Maritime Safety Authority
ANS	Aquatic non-indigenous species
ANSTF	Aquatic Nuisance Species Task Force
APPS	Act to Prevent Pollution from Ships
BWTS	Ballast Water Treatment System
BMP	Best management practice
BOD	Biochemical oxygen demand
CCC	Criterion Continuous Concentration
CDC	Centers for Disease Control
CLIA	Cruise Line International Association
CMC	Criterion Maximum Concentration
COTP	Captain of the Port
CPI	Consumer Price Index
CWA	Clean Water Act
DOD	Department of Defense
EEZ	Exclusive Economic Zone
eNOI	Electronic Notice of Intent
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GLERL	Great Lakes Environmental Research Laboratory
GRT	Gross Registered Tons (1 GRT = 1.875 GT)
GSMFC	Gulf States Marine Fisheries Commission
GT	Gross Tons
IADC	International Association of Drilling Contractors
ICCP	Impressed Current Cathodic Protection
ICST	International Classification of Ships by Type
IDNR	Indiana Department of Natural Resources
IMO	International Maritime Organization
ISA	Infectious salmon anemia
MARPOL	1973/78 International Convention for the Prevention of Marine Pollution from Ships
MISLE	Marine Information for Safety and Law Enforcement
MODU	Mobile Offshore Drilling Unit
NAICS	North American Industry Classification System
NANCPA	Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990
NBIC	National Ballast Information Clearinghouse
NDC	Navigation Data Center
NISA	National Invasive Species Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NoBOB	No ballast on board
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRDC	National Resources Defense Council
NRWQC	National recommended water quality criteria
OTA	Office of Technology Assessment
PAH	Polycyclic aromatic hydrocarbon
PARI	Permit Authorization and Record of Inspection
PFOA	Perfluorooctanoic acid

PFOS	Perfluorooctane sulfonate
POC	Pollutant of concern
RFA	Regulatory Flexibility Act
RO-RO	Roll-on/roll-off
RTF	Ruffe Task Force
SAB	Science Advisory Board
SBA	Small Business Administration
SBAC	Small Business Advocacy Chair
SBREFA	Small Business Regulatory Enforcement and Fairness Act
SIC	Standard Industrial Classification
TBT	Tributyltin
UNDS	Uniform National Discharge Standards
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOI	U.S. Department of the Interior
USGS	U.S. Geological Survey
VDS	Vessel Documentation System
VESDOC	Merchant Vessels of the United States
VHS	Viral hemorrhagic septicemia
VTCC	Vessel Type, Construction, and Characteristics
WCSC	Waterborne Commerce Statistics Center
WHOI	Woods Hole Oceanographic Institute
WTLUS	Waterborne Transportation Lines of the United States

EXECUTIVE SUMMARY

EPA is revising permitting requirements for discharges incidental to the normal operation of non-recreational, non-military vessels into inland waters or the territorial sea of the United States under the National Pollutant Discharge Elimination System (NPDES).

This report presents EPA's economic and benefits analysis of impacts of revisions to the Vessel General Permit on all affected vessels. Though the issuance of this Permit is not a Federal regulation, EPA is conducting this analysis to evaluate the potential impacts of the VGP. This Executive Summary provides an overview of the costs and benefits of VGP revisions.

The Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (herein referred to as the Vessel General Permit or VGP) covers non-recreational and non-military vessels 79 feet or more in length.[1] The VGP defines effluent limits for 27 discharge categories as well as specifying certain practices and discharges for selected vessel categories.[2]

All vessels operating in a capacity of transportation are eligible for coverage under the VGP. The types of vessels covered under the Permit include commercial fishing vessels, cruise ships, ferries, barges, mobile offshore drilling units (MODUs), oil tankers or petroleum tankers, bulk carriers, cargo ships, container ships, other cargo freighters, refrigerant ships, government vessels not a part of the armed forces (e.g. NOAA and USACE vessels), research vessels, and emergency response vessels, including firefighting and police vessels, and any other vessel operating in a capacity of transportation. Vessels of the armed forces of the United States are not eligible for coverage by this Permit. EPA estimates that approximately 58,600 domestic flag and 14,340 foreign flag vessels will be covered under the VGP, but only a subset of these vessels will incur incremental costs as a result of the revised permitting requirements. *Chapter* 2*: Population of Affected Vessels* of this report presents EPA's assessment of the numbers and types of vessels likely to be impacted by the revised permitting requirements.

Water transportation accounts for a majority of the vessels navigating on U.S. waters and covered by the VGP. As of 2007, water transportation was a $48 billion industry that employed over 157,000 people on a payroll of over $8 billion.[3] Overall, the industry has experienced growth in the revenues, payroll and number of employees, but a decline in the number of establishments. The global economic crisis and U.S. recession, post 2007, likely impacted the water transportation as a reduced overall flow of goods reduced shipping volume and other leisure water transportation activities decreased; it also likely also affected the fishing and mining industries. The fishing industry is responsible for slightly more than a quarter of all commercial vessels in the United States. The fishing industry is much smaller, with total revenues of $1.66 billion, employing 5,600 people on a payroll of $302 million. It has experienced a slight increase in number of establishments and payroll, although it has also experienced a decline in the number of employees. The drilling oil and gas wells sector, a subset of the mining

[1] If auxiliary vessels or craft, such as lifeboats or rescue boats less than 79 feet onboard larger vessels require permit coverage, they are eligible for coverage under this permit and are covered by submission of the Notice of Intent for larger vessels. Recreational vessels as defined in section 502(25) of the Clean Water Act are not subject to this permit.

[2] Vessel categories with specific permit requirements include: large cruise ships; medium cruise ships; large ferries; barges; oil tankers or petroleum tankers; research vessels; emergency vessels; and vessels employing experimental ballast treatment systems.

[3] The Economic Census provides the most comprehensive revenue, employment and establishment data at the national level. The Census is conducted every 5 years, with 2007 being the most recent year for which data are available.

industry (which includes the 131 MODUs covered under the VGP), is a $9 billion sector that employs nearly 60,500 people on a payroll of approximately $2.5 billion. This sector has experienced strong growth with a 115 percent increase in revenue from 2002 to 2007. On the whole, the three industries are composed of about 93 percent small businesses. Of the 3,907 firms in the water transportation industry, 3,637 (93.1 percent) are categorized as small. In the fishing industry, 1,843 (96.2 percent) of the 1,916 firms are small. In the drilling oil and gas wells sector, 1,893 (89.9 percent) of the 2,109 firms are small. *Chapter 3: Profile of Water Transportation, Fishing and Mining Industries* provides an economic profile of these industries.

To estimate the effect of revised Permit requirements on an industry as a whole, EPA's analysis takes into account existing conditions and determines how the industry would act in the future in the absence of revised Permit requirements. The baseline for this analysis is full industry compliance with existing federal and state regulations, including the 2008 VGP in the case of vessels currently covered by the permit; and existing industry practices or standards that exceed current regulations to the extent that they can be empirically observed. In addition, a number of laws and associated regulations (including the National Invasive Species Act; the Act to Prevent Pollution from Ships; the Comprehensive Environmental Response, Compensation, and Liability Act; the Organotin Anti-fouling Paint Control Act; and others) already cover certain discharges addressed in the VGP. The overlap between revised permit requirements and existing regulations and practices is discussed at greater length in the sections of the report that address each revised requirement.

Chapter 4: Cost of Best Management Practices presents EPA's analysis of compliance costs to commercial vessels associated with each of the practices and discharge categories identified and the paperwork burden costs. Incremental costs are understood to result from the inclusion of all commercial fishing vessels 79 feet or larger under the 2013 VGP (these vessels were largely not covered by the 2008 VGP), and from revised, more stringent requirements for certain discharge categories and practices. Changes in compliance costs also result from streamlining selected requirements, which is expected to reduce compliance costs for owners of certain vessels. Overall, EPA finds that revisions in the VGP requirements could result in aggregate annual incremental costs for domestic vessels ranging between $7.2 and $23.0 million (in 2010$). This includes incremental paperwork burden costs and the sum of incremental practice costs for applicable discharge categories for all vessels estimated to be covered by the revised VGP. Per vessel incremental compliance costs range between $0 to about $86,300 per year, depending on the number of applicable discharge categories and baseline practices. The maximum value in that range is for a large ship assumed to incur the maximum cost for each and all relevant practices (e.g., a medium cruise ship needing to install a graywater treatment system while also incurring incremental compliance costs for all other applicable discharge categories). Most vessels covered by the VGP incur compliance costs that are much lower, however, as average compliance costs range between $51 and $7,004 per vessel. Tank ships have the highest average compliance costs; this is driven by potential incremental costs for oil tankers exclusively engaged in coastwise trade that may install and operate onboard ballast water treatment systems to meet the 2013 VGP requirements applicable to ballast water discharges. The largest share of the industry-level incremental costs is associated with requirements mandating the use of environmentally acceptable lubricants. As discussed in *Section 4,* there is considerable uncertainty in the assumptions used for several practices and discharge categories and these estimates therefore provide illustrative ranges of the costs potentially associated with the 2013 VGP rather than incremental costs incurred by any given vessel owner. Nevertheless, the estimated compliance costs generally represent a small share of per vessel operating revenue. Hence, EPA finds that meeting the 2013 VGP permit requirements is economically practicable and achievable for permittees.

To evaluate the potential economic impacts of revised VGP requirements on the water transportation, fishing, and mining industries, EPA performed a firm-level analysis. The firm-level analysis examines the impact of any incremental cost per vessel to comply with the revised VGP requirements on model firms that represent the financial conditions of "typical" businesses in each of the examined industry sectors. Since more than ninety percent of the firms in the water transportation and fishing industries, and in the drilling oil and gas wells segment of the mining industry are small, it is unlikely that firm-level impacts would be material among large firms in this industry. Therefore, the firm-level analysis focuses on assessment of impacts on small businesses. To evaluate the potential impact of the VGP on small entities, EPA used a cost-to-revenue test to evaluate the potential severity of economic impact on vessels owned by small entities. The test calculates annualized pre-tax compliance cost as a percentage of total revenues and uses thresholds of 1 and 3 percent to identify entities that would be significantly impacted as a result of this Permit. *Chapter 5: Analysis of Impacts on Firm Revenues and Financial Performance* details EPA's assessment of the cost and economic impact of regulatory requirements on firms in the shipping industry, and the implications of the Permit in terms of financial viability of shipping industry firms subject to the Permit. According to the firm-level analysis, the total number of small entities in the fishing industry that are expected to exceed the one percent cost-to-revenue threshold ranges between 0 and 94 for the low end and high end cost assumptions, respectively. EPA believes the analysis overstates impacts to smaller firms due to modeling assumptions.[4] The total number of small entities in the water transportation industry that are expected to exceed the one percent cost-to-revenue threshold ranges from 76 to 246 under the low and high end cost assumptions, respectively. Overall, approximately 6 percent of firms have costs estimated to exceed the one percent cost-to-revenue threshold and less than one percent of firms have costs estimated to exceed the three percent cost-to-revenue threshold, based on high end cost estimates. As discussed in the Chapter, the methodology used to distribute compliance costs to vessel and firms of different sizes is likely to overstate impacts on small firms.

Although EPA was unable to evaluate the expected benefits of the Permit in dollar terms due to data limitations, the Agency collected and considered relevant information to enable qualitative consideration of ecological benefits and to assess the importance of the ecological gains from revisions to the VGP. EPA expects that reductions in vessel discharges will benefit society in two broad categories: (1) enhanced water quality from reduced pollutant discharges and (2) reduced risk of invasive species introduction. These effects are discussed in *Chapter 6: Benefits Analysis*.

The VGP covers many discharges and contains special provisions for numerous vessel types (see U.S. EPA, 2011) for information on the affected discharges and provisions by vessel type). Many of the discharges regulated by EPA's VGP are associated with a wide variety of harmful pollutants in substantial concentrations. For example, untreated graywater may contain pathogenic bacteria, toxic and carcinogenic organic and inorganic compounds, nutrients, and metals (U.S. EPA, 2008b). Because many of the nation's busiest ports are considered to be impaired by a variety of pollutants found in vessel discharges, strengthening the requirements contained in the VGP, as accomplished by the 2013 VGP revisions, is expected to have benefits associated with the reduction of concentrations of nutrients, metals, oil, grease, and toxics in waters with high vessel traffic.

[4] The distributional analysis model likely overstates impacts to firms in this sector due to methodology limitations discussed in Section 5.3 of this report, notably EPA's conservative assumptions regarding the distribution of vessels to firms across size categories and relatively uniform characteristics of vessels assigned to firms with very different annual revenue.

1 INTRODUCTION

1.1 BACKGROUND

On December 18, 2008, EPA finalized new permitting requirements for discharges incidental to the normal operation of a vessel into inland waters or the 3 mile territorial sea of the United States under the National Pollutant Discharge Elimination System (NPDES) (73 CFR 117). The 2008 Vessel General Permit for Discharges Incidental to the Normal Operation of Non-Recreational Vessels (herein referred to as the Vessel General Permit or VGP) covers all non-recreational non-military vessels of 79 feet or greater, and any non-recreational vessel less than 79 feet in length or commercial fishing vessel of any size discharging ballast water.

On December 8, 2011, EPA proposed revisions to the VGP for the next five-year Permit period that will extend from 2013 through 2018. In its proposal, the Agency also sought comments from regulated entities on certain requirements it introduced for this permit period. EPA considered the public comments in developing the final 2013 VGP analyzed in this report.

To obtain authorization under the 2013 VGP:

- Vessel operators must meet the VGP eligibility requirements.
- Vessel operators must implement the effluent limits according to the requirements in Part 2 of the VGP, and document their implementation as part of their recordkeeping documentation. If the vessel is equipped to carry ballast water or carries ballast water at any time, it must have a ballast water management plan consistent with part 33 CFR 151.2035(a)(7).
- Operators of some vessels will have to submit NOIs. If a vessel weighs at least 300 gross tons or has the capacity to discharge more than 8 cubic meters of ballast water, the operator must submit a complete and accurate NOI. For operators required to submit NOIs, submission must meet specified submission deadlines.
- If the vessel is not in one of the aforementioned categories, it automatically receives permit coverage under the VGP and is authorized to discharge in accordance with Permit conditions. The owner of a vessel not subject to NOI requirements must instead maintain a Permit Authorization and Record of Inspection (PARI) form documenting coverage and annual inspections.

Based on an analysis of several vessel data sources (described in *Section 2*), EPA estimated the population of vessels affected by the NPDES requirements. The total count of the domestic flag vessel population is estimated at 58,602. The foreign flag vessel population totals an estimated 14,340 vessels.

The VGP defines general effluent limits applicable to all discharges; general effluent limits applicable to 27 specific discharge streams; narrative water-quality based effluent limits; inspection, monitoring, recordkeeping, and reporting requirements; and additional requirements applicable to certain vessel types. This report presents EPA's economic and benefits analyses of the 2013 VGP. The economic analysis is being conducted to evaluate the incremental costs that may be incurred by vessel owners in complying with additional requirements of the 2013 VGP and inform EPA's assessment of the practicality of the technologies and practices specified in the permit.[5] The analyses focus on changes to the VGP requirements, relative to requirements contained in the 2008 Permit, which may result in incremental cost (positive or negative) for vessel owners. The cost estimates for the 2008 VGP were documented in the *Economic and Benefits Analysis of the Proposed Final Vessel General Permi*t (EPA, 2008a). Though the issuance of this permit is not a Federal regulation, EPA is conducting these analyses to assess the burden of this permit on all entities, and in particular small entities.

1.2 REPORT ORGANIZATION

This report is organized in seven sections and two appendices, as follows:

Section 2: Population of Affected Vessels presents an assessment of the numbers and types of vessels likely to be affected by the new permitting requirements.

Section 3: *Profile of the Water Transportation, Fishing, and Mining Industries* provides an economic profile of the sectors that have vessels subject to the VGP.

Section 4: *Cost of Best Management Practices* presents EPA's analysis of compliance costs to commercial vessels associated with each of the practices identified by EPA in the 2013 VGP at the vessel level. This chapter also presents an estimation of national-level industry compliance costs.

Section 5: *Analysis of Impacts on Firm Revenues and Financial Performance* presents EPA's assessment of the cost and economic impact of regulatory requirements on firms that own or operate vessels covered by the VGP, and the implications of the Permit in terms of the financial viability of these firms.

Section 6: *Benefits Analysis* presents EPA's assessment of the environmental effects associated with vessel discharges and the benefits of reducing these discharges.

[5] In developing the VGP, EPA evaluated best practicable technologies currently available (BPT). Cost is one of several considerations in determining practicability.

2 POPULATION OF AFFECTED VESSELS

The VGP is applicable to discharges incidental to the normal operation of a vessel into the navigable waters within the meaning of the Clean Water Act (CWA) Section 502(7). Vessels operating in a capacity of transportation are eligible for coverage under the VGP. The types of vessels covered under the VGP include commercial fishing vessels, cruise ships, ferries, barges, mobile offshore drilling units, oil tankers or petroleum tankers, bulk carriers, cargo ships, container ships, other cargo freighters, refrigerant ships, research vessels, emergency response vessels, including firefighting and police vessels, and other vessels operating in a capacity of transportation. Vessels of the armed forces of the United States are not eligible for coverage by this permit as they are subject to Uniform National Discharge Standards (UNDS) under Section 312(n) of the CWA. While all non-recreational, non-military vessels may seek coverage under this permit, the permit requirements are generally targeted to vessels that are at least 79 feet in length. A separate, streamlined permit is available for vessels less than 79 feet (Small Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels Less Than 79 Feet). Consequently, the analysis of the impacts of the VGP considers the population of vessels 79 feet or greater in length only.

EPA used the following data sources to estimate the population of affected vessels:

- *Domestic flag vessels*: The Marine Information for Safety and Law Enforcement (MISLE) and Waterborne Transportation Lines of the United States (WTLUS) databases provided information on the number and type of domestic flag vessels subject to the Vessel General Permit.
- *Foreign flag vessels*: The Foreign Vessel Traffic Entrance and Clearance records of U.S. Customs and Border Protection provided information on the number and type of foreign flag vessels operating in the navigable waters of the United States.
- *Vessels subject to ballast water management requirements*: USCG estimated the number of domestic and foreign vessels that are potentially subject to ballast water requirements (USCG, 2012a). Additional data were obtained from the National Ballast Information Clearinghouse (NBIC) on U.S. port calls, traffic patterns, ballast capacity, whether a vessel declared ballast water on board, and whether ballast water exchange was performed for calendar years 2009 and 2010 (January 1, 2009 through December 31, 2010).
- *Vessels subject to Notice of Intent (NOI) requirements*: EPA has received NOIs from vessel owners and operators seeking coverage under the 2008 VGP. Vessels subject to the NOI requirement are those 300 gross tons or greater or that have the capacity to hold or discharge more than 8 cubic meters of ballast water. EPA used the NOI data to inform the characterization of vessels that would likely also seek coverage under the 2013 VGP and to assess the accuracy of data available from the other sources listed above.

Finally, EPA also used information that was previously compiled for the analysis of the 2008 VGP. This includes information provided by the Cruise Line International Association (CLIA) on the number and size of cruise ships operating in U.S. waters.

2.1 DOMESTIC VESSEL POPULATION

EPA used two primary data sources to determine the population of domestic flag vessels: (1) the MISLE database compiled by the U.S. Coast Guard (USCG, 2009), and (2) the WTLUS data file compiled by the Waterborne Commerce Statistics Center (WCSC) of the U.S. Army Corps of Engineers (USACE) Navigation Data Center (NDC) (USACE, 2009).[6]

MISLE provides a wide range of information regarding vessel and facility characteristics, accidents, marine pollution incidents, and other information pertinent to U.S. Coast Guard operations. MISLE includes data for a total of nearly 1 million vessels that operate in U.S. waters. The database covers a wide ensemble of vessels (e.g., recreational vessels, commercial fishing vessels, freight barges, tank barges, tank ships, passenger vessels, utility vessels), and provides data on various characteristics for each individual vessel. These data include: Identification number(s); Vessel category (e.g., class, type, subtype, service); Size (e.g., tonnage, length, breadth, depth); Area of operation (e.g., hailing port, route type); Passenger and crew capacity; Propulsion (i.e., method, engine type, and horsepower); Construction material and design (e.g., hull material, design type, hull configuration/shape); Year built or age.

WTLUS is a three-volume annual product that provides both an inventory of vessel companies, along with their American flag vessels operating in the transportation of freight and passengers, and a national summary of all vessels. The database lists the vessel companies in alphabetical sequence and provides each vessel's name and number; Coast Guard number; net tonnage; Vessel Type, Construction, and Characteristics (VTCC) code and International Classification of Ships by Type (ICST) code; register and overall length and breadth; loaded and light draft; horsepower; carrying capacity in short tons or units of cargo and number of passengers; height of fixed superstructures; cargo handling equipment; operating headquarters; and year built or rebuilt.

To estimate the domestic vessel population subject to the VGP, EPA created a master database by combining the MISLE and WTLUS data files. The combined database allows the Agency to obtain a comprehensive estimate of the vessel population and to minimize the number of missing data fields for any given vessel.[7] The Coast Guard number, which serves as the unique vessel identifier, was used to combine information across the databases. EPA used the MISLE data as the base of the population and, as a general rule, used the majority of the data fields contained therein, inputting similar data attributes from WTLUS into this format. As shown in *Table 2-1,* the estimated number of domestic flag vessels subject to the Vessel General Permit is 58,602.

[6] Other sources include information submitted by the International Association of Drilling Contractors (IADC), which provided a vessel count of 131 MODUs as part of EPA's analysis of the 2008 VGP.

[7] For example, EPA used values reported in WTLUS to fill in missing MISLE information regarding vessel type, length, and gross tonnage for vessels reported in both databases.

Table 2-1. Domestic Vessel Population

Vessel Type	Total Domestic Vessels	
	Count[a]	Percentage of Vessels
Commercial Fishing [b]	2,326	4%
Freight Barge	39,760	68%
Freight Ship	812	1%
Passenger Vessel	1,970	3%
Tank Barge	7,144	12%
Tank Ship	332	1%
Utility Vessel	6,258	11%
Total	**58,602**	**100%**

Source: Determined from data compiled by the U. S. Coast Guard, MISLE database, 2009 and by USACE, WTLUS 2009.

[a] Includes vessels 79 feet or greater with status noted as "active", "unknown", "laid up" or without status. Excludes vessels identified as duplicate records in the vessel name field. Vessels with unspecified type were assigned to a vessel type based on relative shares of vessel types.

[b] A separate estimate provided by U.S. Coast Guard personnel suggests that commercial fishing vessels 79 feet long or greater number approximately 1,800 to 1,900 vessels.[8]

This analysis examines the following vessel population groups, defined by MISLE and WTLUS categorizations:

- *Commercial Fishing*. Includes fish catching, fish processing, and other fishing vessels.
- *Freight Barge*. Includes open and covered hopper barges, car floats, flat/deck barges, pontoon barges, open and covered dry cargo barges, container barges, lash barges, and convertible barges.
- *Freight Ship*. Includes general cargo freighters, break bulk carriers, roll-on/roll-off (RO-RO) carriers, container ships, partial container ships, refrigerated ships (reefer), and vehicle carriers.
- *Passenger Vessel*. Includes cruise ships, combination passenger and cargo ships, ferries, railroad car ferries, excursion and sightseeing vessels, and passenger barges.
- *Tank Ship*. Includes petroleum, chemical, and liquid gas carriers, and liquid bulk tankers.
- *Tank Barge.* Includes liquid cargo barges that are single hull, double hull, double sided only, and double bottom only.
- *Utility Vessel*. Includes crew boats, mobile offshore drilling units, offshore supply vessels, industrial vessels, oil recovery vessels, research vessels, school ships, push boats, and tug/towing vessels.

As shown in *Table 2-1,* freight barges (68 percent), tank barges (12 percent), and utility vessels (11 percent) account for the majority of domestic vessels eligible for coverage under the VGP.

[8] Personal communication with Jack Kemerer, Fishing Vessel Safety Program, May 26, 2009.

2.2 FOREIGN VESSEL POPULATION

The Foreign Traffic Vessel Entrances and Clearances (FTVEC) database provides information on foreign vessels entering or clearing U.S. Customs. The data are compiled by the U.S. Army Corps of Engineers from information originally collected by U.S. Customs and Border Protection. They include entrance/clearance characteristics such as the date a vessel made entry into or cleared the U.S. Customs port or waterway, as well as vessel characteristics such as the name, type by rig or ICST code, flag of registry, last (for entrances) or next (for clearances) port of call, whether foreign or domestic, Net and Gross Registered Tonnage, and draft in feet. The database includes both foreign flagged and domestic vessels. However, only foreign flagged vessels are included in the estimate of the foreign vessel population. The estimate of the foreign vessel population also excludes several other Permit-exempt boats. Based on data for calendar years 2008, 2009, and 2010, EPA estimates that 14,340 foreign flagged vessels are subject to the VGP requirements.[9]

EPA used ICST codes to group foreign flagged vessels into the classes used in the analysis of the domestic vessel population (i.e., commercial fishing, freight barge, freight ship, passenger vessel, tank barge, tank ship, and utility vessel). *Table 2-2* presents the number of foreign flagged vessels by vessel class. As shown in *Table 2-2,* the majority of foreign flagged vessels entering U.S. ports are freight ships (67 percent), followed by tank ships (25 percent). Of the 14,340 foreign flagged vessels that entered U.S. waters in 2008, 2009, and 2010, 14,187 weigh more than 300 gross tons (approximately 160 gross registered tons) and therefore needed to submit an NOI to EPA based on this applicability criterion. This number appears generally consistent with the number of NOIs that were actually submitted in the following year. For instance, eNOI data as of May 2012 show that 8,040 foreign vessels submitted an NOI electronically during calendar year 2009; the FTVEC data report clearances of 8,339 foreign flagged vessels that same year.[10] Since vessel owners do not need to re-submit an NOI upon returning to the United States from an overseas voyage, the number of NOI submitted in any given year is expected to be only a fraction of the number of vessels that enter U.S. waters during the year.[11] EPA expects that the total number of unique foreign vessels that entered U.S. ports over a 3-year period to be generally indicative of the number of vessels that would need to submit an NOI over the five years of the permit.

[9] EPA determined this vessel count by compiling a list of unique IMO identifiers and vessel names from the FTVEC data for calendar years 2008, 2009, and 2010, excluding vessels identified as US flagged.

[10] The number of NOIs for foreign vessels submitted to EPA during calendar years 2010 was 3,865; FTVEC data show clearances for 3,346 new foreign flagged vessels greater than 300 GT (vessels that did not enter U.S. waters in 2009).

[11] FTVEC data show 5,549 foreign flagged vessels greater than 300 GT that entered U.S. waters in both 2009 *and* 2010.

Table 2-2. Foreign Vessel Population.

Vessel Type	Total Foreign Vessels	
	Count	Percentage of Foreign Vessels
Commercial Fishing	96	<1%
Freight Barge	219	2%
Freight Ships	9,546	67%
Passenger Vessel	217	2%
Tank Barge	51	<1%
Tank Ships	3,579	25%
Utility Vessel	570	4%
Unknown type	62	<1%
Total	**14,340**	**100%**

[a] Includes all vessels identified based on unique IMO numbers.

The foreign flagged vessels are excluded from the analysis of the total costs of implementing pollution prevention and control practices for the relevant discharge categories because the cost to foreign flagged vessels does not have a direct impact on U.S. firms.

2.3 VESSELS SUBJECT TO NOI REQUIREMENTS

The VGP requires owners of vessels meeting the requirements under Part 1.5.1.1 (300 gross tons or greater or has the capacity to hold or discharge more than 8 cubic meters of ballast water) to submit an NOI to EPA to receive permit coverage. In the case of vessels that were authorized to discharge under the 2008 VGP, the NOI must be submitted within 6 months of the effective date of the revised VGP, while vessels not previously covered must submit an NOI at least 30 days before discharging into waters subject to the permit.

EPA estimated the number of vessels required to submit an NOI (e.g., vessels greater than 300 gross tons) using the data sources described above for domestic and foreign vessels and information available from the vessels that submitted an NOI under the 2008 VGP. *Table 2-3* summarizes the counts of domestic and foreign vessels that may be required to submit an NOI to obtain coverage under the 2013 VGP.

Table 2-3. Population of Vessels Required to Submit an NOI.

Vessel Type	Domestic Vessels Required to Submit NOI[a]		Foreign Vessels Required to Submit NOI[b]	
	Count	Percentage of NOIs for Domestic Vessels	Count	Percentage of NOIs for Foreign Vessels
Commercial Fishing	463	1%	58	<1%
Freight Barge	37,516	77%	213	2%
Freight Ships	668	1%	9,530	67%
Passenger Vessel	301	1%	215	2%
Tank Barge	6,466	13%	51	<1%
Tank Ships	283	1%	3,576	25%
Utility Vessel	2,805	6%	483	3%
Total	**48,502**	**100%**	**14,187[c]**	**100%[c]**

Source: Determined from data compiled by the U. S. Coast Guard, MISLE database, 2009; USACE, WTLUS 2009; and USACE FTVEC 2008, 2009, and 2010. Estimates are based on the number of vessel 300 gross tons or greater.

[a] Count based on the number of vessels 300 gross tons or greater. Data from EPA's eNOI system indicate that 28,866 domestic vessels had submitted an NOI through May 8, 2012.

[b] The count of vessels required to submit an NOI is based on data reported in the Foreign Traffic Vessel Entrances and Clearances database. Only vessels 300 gross tons or greater are assumed to be required to submit an NOI. Data from EPA's eNOI system indicate that 19,340 foreign vessels had submitted an NOI through May 8, 2012.

[C] Total includes 61 vessels with an uncategorized vessel type.

As of May 2012, EPA had received 48,206 NOIs for active vessels, including 28,866 domestic and 19,340 foreign vessels.[12]

The higher aggregate number of NOIs EPA received through May 2012 (i.e., 19,340 NOIs, as compared to the 14,187 foreign vessels identified from the FTVEC database) may be due to additional vessels that entered U.S. waters in 2011 and during the first few months of 2012; these vessels would not be reflected in the FTVEC data for 2008 through 2010. When considering specific calendar years, the number of NOIs received by EPA for foreign vessels is generally consistent with the number of new foreign vessels entering U.S. waters during that same calendar year.

The number of NOIs received for domestic vessels is lower than the 48,502 vessels MISLE/WTLUS identifies as 300 gross tons or greater. The difference may be due to inactive vessels being included in MISLE[13] or not all vessels required to submit NOIs may have done so for the 2008 VGP. For the purpose of estimating costs associated with compliance with the 2013

[12] The categorization of vessels as domestic vs. foreign is based on the country of the organization identified in the NOI form as owning or operating the vessel. This country is not necessarily the same as the country where the vessel is registered. For the purpose of this analysis, however, EPA treats the information as equivalent.

[13] MISLE does not report the status of 29,736 vessels. EPA conservatively assumed that these vessels are active and may potentially seek coverage under the 2013 VGP.

VGP, EPA relied on domestic vessel population estimates obtained based on the MISLE/WTLUS database. While this is based on the numbers of NOIs received, as noted above, these databases may overstate the number of domestic vessels subject to the VGP requirements.

2.4 VESSELS SUBJECT TO THE BILGEWATER TREATMENT REQUIREMENTS

The VGP contains requirements to limit the discharge of oily bilgewater. For vessels greater than 400 gross tons, the Permit authorizes the discharge of oily bilgewater provided that these discharges meet specified conditions for maximum oil content, monitoring, and alarms.

EPA estimated the number of vessels greater than 400 gross tons using the data sources described above for domestic and foreign vessels. The data are summarized in *Table 2-4*.

Table 2-4. Population of Vessels Greater than 400 Gross Tons.

Vessel Type	Domestic Vessels Greater than 400 Gross Tons		Foreign Vessels Greater than 400 Gross Tons	
	Count	Percentage of Domestic Vessels	Count	Percentage of Foreign Vessels
Commercial Fishing	405	1%	49	<1%
Freight Barge	36,764	78%	209	2%
Freight Ships	663	1%	9,526	67%
Passenger Vessel	275	1%	214	2%
Tank Barge	6,286	13%	51	<1%
Tank Ships	281	1%	3,576	25%
Utility Vessel	2,474	5%	462	3%
Total	**47,148**	**100%**	**14,147**[a]	**100%**[a]

Source: Determined from data compiled by the U. S. Coast Guard, MISLE database, 2009; USACE, WTLUS 2009; and USACE FTVEC 2008, 2009, and 2010. Estimates are based on the number of vessel 400 gross tons or greater.

[C] Total includes 60 vessels with an uncategorized vessel type.

The population of vessels greater than 400 gross tons is also relevant to evaluating the impacts of requirements applicable to discharges of boiler/economizer blowdown (see Section 4.2.6 of this report) and graywater (see Sections 4.2.25 and 4.3.1) because the VGP sets out differentiated requirements for vessels greater than 400 gross tons for these two discharge categories.

2.5 VESSELS SUBJECT TO THE BALLAST WATER MANAGEMENT REQUIREMENTS

The VGP contains requirements to minimize the risk of introducing invasive species into waters of the U.S. from ballast water discharges. The performance requirements are generally consistent with those finalized by the U.S. Coast Guard in its "Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters", which follow the International Maritime Organization

(IMO) "Regulation D-2" standard of the Ballast Water Management Convention (USCG, 2012a). These standards are described later in this report (Section 4.2.3).[14] The 2013 VGP also specifies additional monitoring, sampling, testing, and reporting requirements for vessels with ballast water treatment systems (BWTS).

The USCG National Ballast Information Clearinghouse provides data from ballast water reports submitted to the USCG by all ballast tank-equipped vessels bound for ports or places of the U.S., in accordance with the National Invasive Species Act of 1996, P.L. 104-332 (NBIC, 2011). This includes those ships that declare no ballast onboard (NOBOB) and ships not discharging ballast water. The NBIC database provides information on each arrival, including vessel name and type, port, state, arrival date, the vessel's last port of call, and information on ballast water management practices (i.e., ballast capacity, volume discharged, whether ballast water exchange was performed, and treatment methods). For calendar years 2009 and 2010, the database records 164,235 arrivals by 8,610 vessels. No ballast water discharge was reported for approximately 70 percent of arrivals (112,841 arrivals by 3,279 vessels). For vessels that reported discharging ballast water (5,331 vessels), about 4,012 vessels conducted ballast water exchange by emptying and refilling their tanks (3,443 vessels) and/or using a flow-through exchange method (1,857 vessels). Finally, there are 76 recorded arrivals of vessels using an alternative ballast management system accepted into the USCG Shipboard Technology Evaluation Program (STEP). While the NBIC database provides a unique identifier (IMO Number) for each vessel that submitted ballast water management reports, the corresponding field in the MISLE/WTLUS database is often empty (these databases generally use the Coast Guard vessel number to uniquely identify each vessel). Because of these data gaps, EPA was able to match only a small subset of the NBIC records (approximately 800 domestic vessels) to corresponding records in MISLE/WTLUS.

Instead, EPA used estimates developed by USCG for the number of vessels potentially affected by ballast water discharge standards, by type of vessel (USCG, 2012a). These estimates exclude vessels that are unlikely to have ballast water tanks, namely those vessels less than 100 feet in length and certain vessel types (e.g., towing vessels, river vessels, crew boats, barges).[15] EPA applied net growth rates assumed in the USCG analysis for each vessel type to estimate the vessel population in 2009, consistent with the data provided in the MISLE/WLUS database. As shown

[14] The standards specify the following maximum discharge limits: (1) For organisms greater than or equal to 50 micrometers in minimum dimension: discharge must include fewer than 10 living organisms per cubic meter of ballast water; (2) For organisms less than 50 micrometers and greater than or equal to 10 micrometers: discharge must include fewer than 10 living organisms per milliliter (mL) of ballast water; (3) Indicator microorganisms must not exceed: (i) For Toxicogenic Vibrio cholerae (serotypes O1 and O139): a concentration of less than 1 colony forming unit (cfu) per 100 mL (ii) For Escherichia coli: a concentration of fewer than 250 cfu per 100 mL (iii) For intestinal enterococci: a concentration of fewer than 100 cfu per 100 mL..

[15] This is reflected in the NBIC data for 2009 and 2010. Bulker and tanker vessels represented 57 percent of vessels that submitted ballast water management reports to NBIC. General cargo and container vessels accounted for another 24 percent. Other vessels included RoRo (6 percent of vessels), reefer (3 percent), passenger (2 percent) and other/unspecified vessels (8 percent).

in *Table 2-5*, a total of 6,934 vessels are estimated to be potentially subject to the VGP ballast water requirements, including 1,665 domestic vessels and 5,269 foreign vessels. The estimate is slightly lower than the 8,609 unique vessels that submitted ballast water management reports to NBIC in calendar years 2009 and 2010.

The 1,665 domestic vessels potentially subject to the ballast water requirements represent approximately 3 percent of the total number of vessels covered by the 2013 VGP (see *Table 2-1*), but account for a significant fraction of freight ships (55 percent), tank ships (22 percent), and utility vessels (14 percent). They also represent relatively small shares of commercial fishing vessels (4 percent) and passenger vessels (8 percent).

Table 2-5. Population of Vessels Subject to Ballast Water Requirements.

Vessel Type	Domestic Vessels Subject to Ballast Water Requirements		Foreign Vessels Subject to Ballast Water Requirements	
	Count	**Percentage of Total**	**Count**	**Percentage of Total**
Commercial Fishing	93	6%	18	0%
Freight Barge				
Freight Ships[a]	450	27%	3,189	61%
Passenger Vessel	154	9%	144	3%
Tank Barge				
Tank Ships[b]	72	4%	1,862	35%
Utility Vessel[c]	895	54%	57	1%
Total	**1,665**	**100%**	**5,269**	**100%**

Source: USCG (2012a). See Table 2.2. The number of vessel was projected from the 2007 estimates using growth and replacement rates provided in Table 2.3.

a Category includes container ships, RoRo, combination vessels, and general cargo vessels. The number of freight ships estimated to be potentially subject to the ballast water requirements exceeds the total number of freight ships in the MISLE/WTLUS database.

b Category includes bulk carriers, tank ships, gas carriers, and chemical carriers.

c Category includes offshore supply vessels.

2.6 UNCERTAINTIES AND LIMITATIONS

This section discusses limitations and uncertainties in the estimation of the affected vessel population. Whether these limitations and uncertainties, taken together, are likely to lead to an understatement or overstatement of the estimated vessel population is not known.

The domestic vessel population was estimated using the MISLE database, supplemented with data from WTLUS and from the eNOI database. The main limitations of the MISLE data include:[16]

[16] See EPA (2010) for a more detailed discussion of the limitations of MISLE data.

- *Incomplete data*. While MISLE represents the most comprehensive national dataset currently available, it does not capture the entire universe of vessels operated on U.S. waters. Only limited information is available for certain classes of vessels due to the way in which vessel data are gathered since these vessels are not subject to documentation or regular inspection requirements. In compiling MISLE data, the U.S. Coast Guard largely relies on documents submitted by vessel owners or operators in accordance with vessel documentation requirements (e.g., certificate of documentation) or on information gathered by U.S. Coast Guard staff directly (e.g., during inspections, vessel boardings, or accident investigations).[17] The scope of the MISLE database is not limited to a certain size or class of vessel, but the content of the database is nonetheless driven in part by the regulatory requirements to which different types of vessels are subject or by activities conducted by Coast Guard offices. MISLE therefore, is generally considered to be most comprehensive for those vessels that are documented, state registered, and/or subject to inspection requirements. Data omissions are believed to affect primarily recreational and smaller commercial vessels. Since the VGP is targeted to larger, non-recreational vessels 79 feet or greater in length, EPA believes that the MISLE data limitations are not consequential for this analysis.
- *Missing or outdated data.* While MISLE captures a wide range of characteristics for each vessel it records, the information is at times incomplete (e.g., length may be missing or recorded as zero) or may be outdated (e.g., a vessel may no longer be operating even as its status in the database suggests that it is). Even after merging databases and using methods to maximize the amount of available data, several data fields remained with non-negligible deficiencies. EPA used conservative assumptions to impute values for some, but not all, of these fields. For example, EPA conservatively included in the potentially affected vessel population a proportional share of vessels for which the length was unknown and all vessels that met the VGP applicability criteria. By including all vessels in MISLE even when these vessels were not also reported in WTLUS, EPA generally erred on the side of a more inclusive VGP population. It is likely, however, that some vessels recorded in MISLE are no longer active and therefore the vessel population may be overestimated.
- *Conflicting vessel classifications.* A relatively small number of vessels were found to be classified by MISLE and WTLUS differently. In these cases EPA used the WTLUS classification and ignored the classification provided in MISLE since the WTLUS data are published and therefore assumed to have been subjected to closer accuracy review.
- *Estimate of vessels required to submit an NOI:* The count of vessels required to submit an NOI is a conservative estimate since data on gross tonnage are not complete. Thus, this

[17] The MISLE database incorporates data reported separately in VESDOC for documented vessels. VESDOC is a data file of merchant and recreational vessels documented under the laws of the United States by the U.S. Coast Guard. That dataset was used for the economic analysis of the 2008 VGP (Abt Associates, 2008).

count is based on the number of vessels that are either greater than 78 feet in length or greater than 299 Gross Tons. As discussed in *Section 2.3*, population estimates derived based on MISLE/WTLUS (48,502 domestic vessels) are significantly higher than the actual number of domestic vessels that sought coverage under the 2008 VGP through May 8, 2012 (28,866 vessels). EPA's use of the MISLE/WTLUS data as the primary source of population estimates for economic analyses is likely, therefore, to overstate the number of vessels subject to VGP requirements, and the associated costs of Permit revisions.

The estimated number of foreign vessels affected by the VGP was estimated using vessel entrances and clearances data for 2008, 2009, and 2010. The data source does not include vessel length and EPA therefore assumed that all vessels that entered U.S. waters during any of the three years are potentially subject to the VGP requirements.

The estimated number of vessels affected by the ballast water management requirements is based on estimates developed by the USCG (2008), complemented by information from NBIC (2011). NBIC identifies vessels by their IMO number as compared to the Coast Guard identifier used in the MISLE/WTLUS databases. Because of the different identifiers, EPA was unable to match a significant fraction of the NBIC records to MISLE/WTLUS and therefore used USCG estimates as the primary information source. While the number of vessels estimated to be potentially subject to ballast water requirements is generally similar to vessels that submitted reports to the NBIC in 2009 or 2010, the number is greater than the number of vessels that reported any ballast water discharge during the two years. Therefore, the estimate possibly overstates the number of vessels that would need to implement additional practices to comply with ballast water requirements in the 2013 VGP. Further, only a subset of vessels that presently discharge ballast water will install ballast water treatment systems and would have to implement the related permit practices.

Finally, the estimate of the population of affected vessels is also subject to the reporting accuracy of the data providers. Typographical errors and incorrect entries (including potential duplicate entries) exist to an unknown extent. Those that were discovered during EPA's review of the data were corrected.

3 PROFILE OF THE WATER TRANSPORTATION, FISHING, AND MINING INDUSTRIES

3.1 INTRODUCTION

The water transportation, fishing, and mining industries consist of the establishments that own and operate the commercial vessels subject to the revised VGP. This section describes the characteristics of these industries that may be relevant to evaluating the economic impacts of revised permit requirements.

According to the Bureau of Transportation Statistics (BTS), maritime transportation carries over three quarters of the weight of all U.S. international freight, and 14 percent of all commercial freight in the United States. While domestic waterborne ton-miles and tonnage declined in the period of the early 1990s through 2003, the value, tons, and ton-miles as international trade grew during this period.

As of 2007, the water transportation industry was a $34 billion industry that employed nearly 150,000 people on a payroll of just over $6 billion. The fishing industry was much smaller, with total revenues of $1.65 billion, employing just over 6,500 people on a payroll of $253 million. The drilling oil and gas wells sector (a subset of the mining industry) was a $9 billion sector that employs nearly 60,500 people on a payroll of approximately $2.5 billion.

Water transportation accounts for a majority of the vessels sailing on U.S. waters and is made up of several industry sectors, described in *Section 3.2.2: Water Transportation*. Overall, the industry has experienced mild growth in the number of establishments, revenues, and payroll, but a decline in the number of employees.

The fishing industry is responsible for slightly more than a quarter of all commercial vessels in the United States, although a relatively small fraction of these vessels are greater than 79 feet and would therefore be covered under the VGP. The industry has experienced a decline in the number of establishments, employees, and payroll, although its revenue grew.

The drilling oil and gas wells sector, which covers the 131 MODUs covered by the VGP, has experienced robust growth, demonstrating a 15 percent increase in revenues from 2002 to 2007.[18]

The number of domestic vessels operating in U.S. waters has remained relatively constant over the last few years, with the total number of documented vessels going from 39,641 vessels in 2000, to 41,354 in 2005, and 40,301 in 2008, the most recent year with published statistics (USACE, 2009).

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[18] The 131 MODUs only account for a small percentage of establishments reported in the 2007 Economic Census for the drilling oil and gas wells sector overall: 131 out of 2,109 establishments. Other establishments classified in the drilling oil and gas wells sector conduct operations that do not involve the use of MODUs; for example, these firms may drill oil and gas wells on land.

3.1.1 DATA SOURCES USED

EPA developed overviews of the various industry sectors using information from industry groups, trade associations, and other reference sources.

Data for the number of vessels were extracted from the combined vessel information of MISLE and WTLUS (detailed further in *Section 2: Population of Affected Vessels*) and from information submitted by the IADC on the number of MODUs. NAICS codes were assigned to vessels according to the NAICS codes of their owner/operators, which were obtained from the Dun & Bradstreet (2006), ReferenceUSA (2006) or manta.com databases. In selected instances where it was not possible to match a vessel owner or operator to a record in these other databases, EPA assigned the most likely NAICS code based on key words in the reported name of the vessel owner where it could do so with reasonable confidence.[19] In cases where owner/operator information was unavailable, no corresponding entry could be found in the business databases, or the name of the owner was not descriptive enough to assign a NAICS sector, the most likely NAICS code was assigned to a vessel using information on vessel type and area of operation. Finally, any remaining unassigned vessels were distributed to the NAICS sectors proportionally to the population analyzed for the 2008 VGP (EPA, 2008a).

Overviews of the various industry sectors were developed using information from industry groups, trade associations, and other reference sources. Data for numbers of firms, establishments, revenues, and employment were obtained from the U.S. Census Bureau and are current as of 2007, with the exception of data for NAICS code 11411: Fishing which is not covered by the Economic Census. In this case, the data come from the U.S. Small Business Administration (SBA).

3.1.2 ORGANIZATION OF THIS CHAPTER

This chapter presents an overview of the water transportation, fishing, and mining industries.

Section 3.2 provides definitions and overviews of the industries and their sectors, as well as the number of vessels associated with each industry, as classified by NAICS.

Section 3.3 summarizes recent trends in these industries, including changes in the number of establishments and financial performance.

Section 3.4 describes the industries' market structures, including details of performance according to employment size, numbers and percentages of small businesses, employment trends, and payroll trends.

[19] For example, companies whose name contained the terms "charter", "tour", or "adventure" were associated with establishments operating in the sector NAICS *487210: Scenic and Sightseeing Transportation, Water*.

3.2 OVERVIEW OF THE WATER TRANSPORTATION, FISHING, AND MINING INDUSTRIES

3.2.1 DEFINITION OF THE WATER TRANSPORTATION, FISHING, AND MINING INDUSTRIES

The water transportation industry, for the purpose of this chapter, includes NAICS codes 483: Water Transportation; 4872: Scenic and Sightseeing Transportation, Water; and 4883: Support Activities for Water Transportation. The fishing industry includes NAICS 1141: Fishing. The mining industry includes NAICS 213111: Drilling oil and gas wells. *Table 3-1* lists the relevant NAICS codes for the water transportation, fishing, and mining industries.

Table 3-1. Principal 2007 NAICS Codes and Descriptions Relevant to Vessels Covered by the VGP.

Industry Group/NAICS Code	Description
Fishing	
1141	Fishing
114111	*Finfish Fishing*
114112	*Shellfish Fishing*
114119	*Other Marine Fishing*
Water Transportation	
4831	Deep Sea, Coastal, and Great Lakes Water Transportation
483111	*Deep Sea Freight Transportation*
483112	*Deep Sea Passenger Transportation*
483113	*Coastal and Great Lakes Freight Transportation*
483114	*Coastal and Great Lakes Passenger Transportation*
4832	Inland Water Transportation
483211	*Inland Waterways Freight Transportation*
483212	*Inland Waterways Passenger Transportation*
4872	Scenic and Sightseeing Transportation, Water
4883	Support Activities for Water Transportation
488310	*Port and Harbor Operations*
488320	*Marine Cargo Handling*
488330	*Navigational Services to Shipping and Salvage*
488390	*Other Support Activities for Water Transportation*
Support Activities for Mining	
2131	Support Activities for Mining
213111	*Drilling Oil and Gas Wells sector*
213112	*Support Activities for Oil and Gas Operations*

Source: U.S. Census Bureau, 2007

3.2.2 WATER TRANSPORTATION

Establishments in the water transportation industry provide water transportation of passengers and cargo using watercraft, such as ships, barges, and boats. The industry is composed of two industry groups: (1) one for deep sea, coastal, and Great Lakes water transportation; and (2) one for inland water transportation. This split typically reflects the difference in equipment used (U.S. Census Bureau, 2007a).

Scenic and sightseeing water transportation services are also included under this industry heading, as are support activities for water transportation. These two industry groups are technically classified outside of Water Transportation (NAICS 483) by the Census Bureau, but are included under water transportation for the purposes of this chapter.

Total waterborne commerce in the United States has increased steadily over the past 50 years, fueled mostly by growth in foreign commerce, which overtook domestic shipments (in terms of weight) in the mid-1990s. Foreign commerce accounted for over 60 percent of total waterborne commerce by weight in 2009, amounting to 1.4 billion short tons out of total U.S. waterborne commerce of 2.2 billion short tons (USACE, 2009).

DEEP SEA, COASTAL, AND GREAT LAKES WATER TRANSPORTATION

This industry group comprises establishments primarily engaged in providing deep sea, coastal, and Great Lakes water transportation, as well as transportation via the St. Lawrence Seaway. Marine transportation establishments using the facilities of the St. Lawrence Seaway Authority Commission are considered to be using the Great Lakes Water Transportation System (U.S. Census Bureau, 2007a). Firms in this NAICS grouping are further classified based on their area of operation (deep sea or coastal/Great Lakes) and payload type (cargo or passengers).

Deep Sea Freight Transportation

The businesses in this industry sector are primarily engaged in providing deep sea transportation of cargo to or from foreign ports. This sector encompasses oceangoing barges, oil tankers, and other large freight vessels (U.S. Census Bureau, 2007a). A large portion of U.S. foreign trade merchandise (1.4 billion metric tons) is transported via water, making this sector the cornerstone of U.S. international trade.

Because of its close relationship to international trade, deep sea freight transportation has been increasing steadily over the past 20 years, driven by increasing imports to the United States from foreign ports.

Over the last half-century, the United States' merchant fleet has declined in number. Though the U.S. vessel fleet has shrunk, it has also become more efficient, with today's merchant vessels carrying 40 percent more cargo and requiring fewer crew members (Transportation Institute, undated).

Deep Sea Passenger Transportation

Establishments in this sector are primarily engaged in providing deep sea transportation of passengers to or from foreign ports (U.S. Census Bureau, 2007a). The most common type of deep sea passenger transportation is the cruise ship.

This leisure-based industry sector is more vulnerable to economic fluctuations, since its revenues draw on discretionary consumer spending. The global economic crisis and recession greatly reduced consumers' disposable income and thus their leisure spending (U.S. BEA, 2011a). It is likely that the scenic and sightseeing transportation sector was impacted by the recession.

Coastal and Great Lakes Freight Transportation

Firms transporting cargo in coastal waters; the Great Lakes System (including the St. Lawrence Seaway); or deep seas between ports of the United States, Puerto Rico, and U.S. island possessions or protectorates fall into this NAICS code classification (U.S. Census Bureau, 2007a).

The Jones Act of 1920 requires that all domestic waterborne trade (between two points in the United States) be conducted on vessels built in the United States, documented in the United States, and owned by U.S. citizens or companies (Transportation Institute, undated). Vessels operating in the Coastal and Great Lakes Freight Transportation sector are subject to this law.

The majority of the vessels in this sector are barges, though the sector is also characterized by its use of other freight transport vessels, as well as tugboats (Transportation Institute, undated). In the Great Lakes, the transportation system comprises bulk cargo carriers, ocean going vessels and smaller cruise ships.

Coastal domestic trade to and from Alaska, Hawaii, and U.S. Territories consists mainly of the shipment of petroleum and petroleum products, chemicals, and agricultural products. The primary products transported on the Great Lakes System are coal, limestone, and iron ore (Transportation Institute, undated; Quinn, 2002). A relatively large share of these vessels is expected to be greater than 79 feet in length and therefore subject to the VGP.

Coastal and Great Lakes freight transportation accounts for nearly 30 percent of all U.S. domestic waterborne shipments by weight in 2009, or 857 million short tons. Coastal and Great Lakes freight transport accounts for almost 90 percent of all self-propelled traffic, but only 13% of barge traffic by weight (USACE, 2009). Great Lakes freight transportation (domestic and foreign) was relatively constant from 1990 to 2005, ranging between 150 and 200 million short tons per year. Tonnage decreased below 150 million tons in 2007 and was significantly less in 2009, at about 100 million tons (USACE, 2009). Generally, approximately two-thirds of Great Lakes tonnage is domestic freight and one-third is foreign (this pattern remained even after the decline in tonnage) (USACE, 2009).

Coastal freight transportation experienced the same post-2005 decline with 1.4 billion tons shipped in 2009, down from 1.6 billion shipped in 2006. This reversed the growing trend observed between 1990 and 2005 when coastal freight transportation increased from around 1.1 billion tons per year to more than 1.6 billion tons, as a result of increased foreign shipments (USACE, 2009).

Coastal and Great Lakes Passenger Transportation

This industry sector contains establishments primarily engaged in providing water transportation of passengers in coastal waters, the Great Lakes System (including the St. Lawrence Seaway), or deep seas between ports of the United States, Puerto Rico, and United States island possessions and protectorates. This industry sector includes many coastal and Great Lakes ferries used to travel short distances between coastal ports, or from shores to nearby islands, as well as larger vessels used on the Alaska Marine Highway, which travels between ports on the southern coast of Alaska and northwestern Canada (Reference for Business, 2007c).

INLAND WATER TRANSPORTATION

Businesses primarily engaged in providing inland water transportation of passengers and cargo on lakes, rivers, or intracoastal waterways (except on the Great Lakes System) are classified under this NAICS grouping, and are further classified between freight and passenger transportation (U.S. Census Bureau, 2007a).

As required by the Jones Act, all vessels in this industry sector are domestic flagged and owned.

Inland Waterways Freight Transportation

The companies in this industry sector are primarily engaged in providing inland water transportation of cargo on lakes, rivers, or intracoastal waterways (except on the Great Lakes System) (U.S. Census Bureau, 2007a). This sector contains a large portion of the vessels in the United States, as it encompasses river barges, as well as the tug and towboats that propel them. The vast majority of boats in this sector are barges, which outnumber other inland freight vessels by about 10 to 1 (Transportation Institute, undated).

The products carried by this industry sector include more than half of U.S. grain shipments, a quarter of chemical and petroleum exports, and a fifth of domestic coal shipments (Transportation Institute, undated). Barges account for 79 percent of domestic waterborne freight.

Inland waterways freight transportation, similar to Great Lakes and coastal water transportation has experienced a decrease in cargo tonnage since 2006, although prior to this the total tonnage transported had remained constant over the past two decades (USACE, 2009). Nevertheless, inland waterways transport accounts for over 50 percent of all domestic waterborne freight shipments (USACE, 2009).

Inland Waterways Passenger Transportation

This industry sector provides inland water transportation of passengers on lakes, rivers, or intracoastal waterways (except on the Great Lakes System) (U.S. Census Bureau, 2007a). This sector includes water taxis and ferries (except coastal and Great Lakes ferries), usually traveling short distances between inland ports, such as in New York harbor or in San Francisco Bay.

The ferry industry has been rebounding from historic lows in the 1970s, and short-distance ferries in urban areas have become alternatives to crowded highways and urban transit systems. In 2000, the 677 ferries operating in the United States served 578 destinations along 352 routes, transporting 113 million passengers (these figures include coastal and Great Lakes ferries) (Reference for Business, 2007c).

SCENIC AND SIGHTSEEING TRANSPORTATION, WATER

This industry group comprises establishments primarily engaged in providing scenic and sightseeing transportation on water. The services provided are usually local and involve same-day return to place of origin (U.S. Census Bureau, 2007a).

This sector encompasses a wide variety of vessel types, from small "swamp buggies" used to tour the Florida Everglades to chartered dinner cruisers to larger whale-watching boats. The range of services offered has continued to expand over the past decade, with gambling boats becoming popular in Indiana and Iowa, and similar gaming "cruises-to-nowhere" becoming popular in Florida (Reference for Business, 2007d).

This leisure-based industry sector is more vulnerable to economic fluctuations, since its revenues draw on discretionary consumer spending. The global economic crisis and recession greatly reduced consumers' disposable income and thus their leisure spending (U.S. BEA, 2011a). It is likely that the scenic and sightseeing transportation sector was impacted by the recession.

SUPPORT ACTIVITIES FOR WATER TRANSPORTATION

This NAICS grouping includes establishments classified in the following NAICS sectors: 48831, Port and Harbor Operations; 48832, Marine Cargo Handling; 48833, Navigational Services to Shipping and Salvage; and 48839, Other Support Activities for Water Transportation (U.S. Census Bureau, 2002).

Businesses in these sectors are the link between a vessel's load (cargo or passengers) and that load's final destination. This sector provides the highest percentage of employment in the water transportation industry, as many of these services are labor-intensive.

Port and Harbor Operations

Businesses in this industry sector operate ports, harbors (including docking, pier and waterfront terminal facilities), or canals (U.S. Census Bureau, 2007a). Vessels in port and harbor operations may be involved in maintaining upkeep of harbor via dredging silt, clearing foreign debris, or assisting with construction projects (Reference for Business, 2007f). Vessels, such as tugboats, may also be responsible for assisting larger vessels in docking maneuvers in harbors and towing vessels. As of 2008, there were 5,425 towboats in the U.S. fleet (USACE, 2009). The private tugboat industry experienced a boon in late 1990s when the U.S. Navy began chartering tugs instead of replacing its fleet (Reference for Business, 2007g). The vessels in this industry sector are likely to be smaller, auxiliary vessels as opposed to the large container ships and barges that they serve.

Marine Cargo Handling

This industry comprises establishments primarily engaged in providing stevedoring and other marine cargo handling services (except warehousing) (U.S. Census Bureau, 2007). This sector contains only a small number of vessels, as most of its business is land-based.

This particular industry sector, along with port and harbor operations, has been growing over the last decades as a result of the increase in foreign trade, mostly with Asian countries. Marine cargo handling and port and harbor operations on the Pacific Coast account for about half of all such operations in the United States (Reference for Business, 2007e).

Despite the increase in volume of shipments handled, employment in marine cargo handling, as well as in port and harbor operations, has been on the decline in recent years, due to increased automation of tasks and other technological advances that reduce the need for manual labor. The industry's unions, the International Longshoremen's Association and the International Longshore and Warehouse Union, are nevertheless still strong and maintain high membership rates (Reference for Business, 2007e). Nevertheless, the decline in volume of shipments due to the recession undoubtedly impacted employment in these indirect industries.

Navigational Services to Shipping and Salvage

This NAICS classification includes two main types of businesses: navigational services to shipping and marine salvage (U.S. Census Bureau, 2002).

Vessels in this industry do not typically carry passengers or cargo, but rather assist larger vessels in entering and leaving port, or in other operations. The salvage subsector of this industry sector includes maintenance vessels that prepare ships for salvage and scrap.

Other Support Activities for Water Transportation

Other auxiliary services of the water transportation industry are grouped into this category, which includes maintenance, repair and salvaging of vessels, inspections, security, and other operations. In recent years, many ship repair companies have been hesitant to work on vessels due to liability concerns, and underwriters have been cautious of paying claims that are the result of poor maintenance; these uncertainties have kept the industry from expanding (Reference for Business, 2007f). Additionally, traditional salvage jobs decreased in the 2000s, potentially due to environmental concerns (Reference for Business, 2007f). However, after the terrorist attacks of 2001, there was a growth in the marine and cargo security industry (Reference for Business, 2007f).

3.2.3 FISHING

The fishing industry includes commercial catching or taking of finfish, shellfish, or miscellaneous marine products from a natural habitat, such as the catching of bluefish, eels, salmon, tuna, clams, crabs, lobsters, mussels, oysters, shrimp, frogs, sea urchins, and turtles (U.S. Census Bureau, 2007a).

Since the 1990s, finfish volume has been declining, due to severely depleted fisheries in the Atlantic and loss of breeding grounds to pollution, as well as to increasingly strict regulations aimed at preventing these problems (Reference for Business, 2007a, b). Demand has not been strong enough to prevent declines in the value of the catches. Shellfish volume has remained relatively constant, with the total value of the catch increasing slightly. Fish and seafood imports have increased over the same period, intensifying the competition in this industry (National Marine Fisheries Service, 2003).

In 2009, Alaska led the nation in both volume and value of fish caught. Louisiana and Virginia were second and third respectively in volume of fish caught, while Massachusetts and Maine were second and third in terms of value of fish landings (National Marine Fisheries Service, 2011).

While the overall fishing industry counts over 65,000 vessels, only an estimated 4 percent of the commercial fishing vessels operating domestically are greater than 79 feet in length, according to data from MISLE (see Section 2), and are therefore covered by the VGP.

3.2.4 MINING

The mining industry comprises establishments that extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas. Within the mining industry, the drilling oil and gas wells sector (NAICS 213111) operates vessels covered by the VGP, including 131 MODUs. This sector comprises establishments primarily engaged in drilling oil and gas wells for others on a contract or fee basis (U.S. Census Bureau, 2007a). According to data provided by the IADC, the 131 MODUs covered by the VGP include 5 drillships, 24 semi-submersible units, 5 submersible units, 40 inland barge units, and 57 jackup units (IADC, 2007). Note that these MODUs represent only a very small fraction of the total number of establishments reported overall in the drilling oil and gas wells sector, as described in *Section 3.3.2*.

In the remainder of this report, unless otherwise noted, the term *mining industry* refers more specifically to the drilling oil and gas wells sector within the industry rather than the mining industry as a whole.

3.3 RECENT TRENDS

This section reviews the recent trends in the water transportation and fishing industries in terms of number of firms, numbers of vessels, and financial performance. It also highlights trends in the drilling oil and gas wells sector of the mining industry.

The reference period is from 2002 through 2007, the years of the two most recent Economic Censuses, except for the number of vessels which is measured between 2007 and 2008.

Overall, the water transportation and fishing industries saw a decline in the number of firms and total revenues. In contrast, the drilling oil and gas wells sector experienced relatively strong firm, revenue, and employment growth. The number of vessels was generally unchanged in the most recent years for which statistics are available and relative to the universe of vessels that was considered by EPA during the development of the 2008 VGP.

Employment, establishment, and payroll data for the Fishing Industry for 2007 are from the County Business Patterns dataset because the fishing industry is not included in the Economic Census. In cases where Fishing Industry data were not available from the Census Bureau, they were obtained from the Small Business Administration.

3.3.1 NUMBER OF VESSELS BY INDUSTRY SECTOR

Table 3-2 shows changes in the number of vessels between 2000 and 2008, according to the WTLUS database (USACE, 2009).[20] Over this period, the WTLUS database recorded a loss of one percent in the total number of non fishing vessels, although some vessel types (e.g., towboats, tank barges) saw their counts increase slightly.

Table 3-2. Number of Vessels in the WTLUS Database, 2000-2008.

Vessel Type	2000	2005	2007	2008	% Change (2007-08)
Self-Propelled					
Dry Cargo and/or Passenger, Offshore Support	2,780	2,967	3,001	2,985	-1%
Vehicular Ferries and Railroad Cars	292	619	604	578	-4%
Tankers	135	100	80	76	-5%
Towboats	4,995	5,290	5,356	5,424	1%
Total – Self-Propelled	*8,202*	*8,976*	*9,041*	*9,063*	*0%*
Non-Self-Propelled					
Barges, Dry Cargo	27,342	29,107	27,162	26,652	-2%
Barges, Tanker	3,985	4,011	4,467	4,560	2%
Railroad Car Floats	33	34	25	26	4%
Subtotal-non Self-Propelled	*31,360*	*33,152*	*31,654*	*31,238*	*-1%*
TOTAL-Vessels[a]	**39,641**	**41,354**	**40,695**	**40,301**	**-1%**

Source: U.S. Army Corps of Engineers, 2009.

Note: Timeseries data on the number of fishing vessels could not be found.

3.3.2 NUMBER OF ESTABLISHMENTS BY INDUSTRY SECTOR

Table 3-3 summarizes the changes in numbers of establishments for each sector of the water transportation, fishing, and mining industries between 2002 and 2007. The water transportation industry experienced a decrease of 4.1 percent in the number of establishments over this period, although deep sea, coastal and great lakes water transportation experienced a much greater decline. Conversely, inland water transportation and scenic and sightseeing transportation both experienced a marginal increase in the number of establishments. The mining industry also experienced an increase in number of establishments.

The largest increase in the number of establishments was in coastal and Great Lakes passenger transportation for which Census reports a 61 percent change in the number of establishments over the five-year period. Inland waterways freight transportation grew 9 percent in number of establishments, and port and harbor operations and navigational services to shipping and salvage both grew by 11 to 12 percent. The fishing industry and the drilling oil and gas wells sector

[20] These vessel totals only include vessels in the WTLUS database, and do not encompass those vessels listed only in MISLE as the MISLE database was only available for one year.

experienced 10 and 8 percent increases in the number of establishments, respectively, between 2002 and 2007.

Table 3-3. Number of Establishments by Industry Sector, 2002 and 2007.

NAICS Description	2002	2007	% Change
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation			
Deep Sea Freight Transportation	456	360	-21.1%
Deep Sea Passenger Transportation	87	55	-36.8%
Coastal and Great Lakes Freight Transportation	677	527	-22.2%
Coastal and Great Lakes Passenger Transportation	114	184	61.4%
Subtotal-Deep Sea, Coastal, Great Lakes	*1,334*	*1,126*	*-15.6%*
Inland Water Transportation			
Inland Waterways Freight Transportation	321	351	9.3%
Inland Waterways Passenger Transportation	269	244	-9.3%
Subtotal Inland	*590*	*595*	*0.8%*
Scenic and Sightseeing Transportation			
Scenic and Sightseeing Transportation, Water	1,726	1,740	0.8%
Support Activities for Water Transportation			
Port and Harbor Operations	233	262	12.4%
Marine Cargo Handling	567	495	-12.7%
Navigational Services to Shipping and Salvage	778	864	11.1%
Other Support Activities for Water Transportation	924	819	-11.4%
Subtotal-Support Activities	*2,502*	*2,440*	*-2.5%*
TOTAL-Water Transportation	**6,152**	**5,901**	**-4.1%**
Fishing Industry			
Fishing	1,916	2,062[a]	7.6%
Mining Industry			
Drilling oil & gas wells sector	1,926	2,109	9.5%

Source: U.S. Census Bureau, 2002a, 2002b, 2007a, 2007b;

a Based on reporting requirements for the data source, the number of establishments only includes firms with full-time employees.

3.3.3 ESTABLISHMENT AND EMPLOYMENT BIRTHS AND DEATHS

Table 3-4 summarizes average establishment birth and death rates for each industry sector for which these data were available. The reference period for these trends is 2002–2007. Birth and death rates in the water transportation and fishing industries average between about 5 and 15 percent of their total numbers of establishments.[21]

[21] For the mining industry, the fraction is based on births and deaths relative to the 9,935 establishments reported in the 2007 Economic Census for NAICS 213 – Support activities for mining. According to the 2007 Economic Census, the drilling oil and gas wells sector (NAICS 213111) represented about a fifth (2,109 establishments) of the establishments reported in the support activities for mining sector (NAICS 213) that year.

For deep sea, costal and great lakes water transportation and support activities for water transportation, deaths outnumber births. However, for inland water transportation and scenic and sightseeing transportation births outnumber deaths. The largest average net change occurred in scenic and sightseeing water transportation, with an average of 28 establishment births per year.

The fishing industry averaged a net change of eight establishment births per year between 2002 and 2007, while the support activities for mining sector averaged a net change of over 450 births per year between 2002 and 2007.

Table 3-4. Establishment Births and Deaths, Five-Year Annual Average: 2002-2007.

Industry Sector	Net Change	Births	Deaths
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation	-9.8	133.8	143.6
Inland Water Transportation	9.6	90.0	80.4
Scenic and Sightseeing Transportation, Water	27.6	192.0	164.4
Support Activities for Water Transportation	-5.6	182.0	187.6
Water Transportation Industry Average	*6.7*	*184.7*	*178.0*
Fishing Industry			
Fishing	8.0	228.8	220.8
Mining Industry			
Support Activities for Mining[a]	458.6	1,155.6	697.0

a Data were only available for NAICS 213 (Support Activities for Mining) and were not available at the 6-digit NAICS level. The 2002 Economic Census reports 9,104 establishments in NAICS 213.

Source: U.S. SBA, 2007a

Table 3-5 summarizes the net change in employment (difference between births and deaths) for each industry sector for which these data are available. Specific information on job creation and elimination was not available for many industry sectors.

All the water transportation sectors had an average net gain of jobs over the five years. Support activities for water transportation averaged the largest change in employment per year, with an average of 2,111 jobs created per year. Scenic and sightseeing transportation also averaged more than 1,000 jobs created per year between 2002 and 2007. Inland water transportation and deep sea, coastal and Great Lakes water transportation averaged net job creation rates of 573 and 510 employees per year, respectively.

The fishing industry averaged a decline of 149 jobs per year over the same period whereas the support activities for mining sector (NAICS 213) averaged an increase of nearly 33,115 jobs per year. According to the 2007 Economic Census, the drilling oil and gas wells sector (NAICS 213111) accounts for a little under a third of the paid employees reported overall in the support activities for mining sector (NAICS 213) (106,859 paid employees as compared to 368,613 paid employees).

Table 3-5. Net Change in Employment: Five-Year Annual Average, 2002-2007.

Industry Sector	Net Change
Water Transportation Industry	
Deep Sea, Coastal, and Great Lakes Water Transportation	509.8
Inland Water Transportation	573.2
Scenic and Sightseeing Transportation, Water	1,058.8
Support Activities for Water Transportation	2,111.6
Water Transportation Industry Average	*983.9*
Fishing Industry	
Fishing	-149.2
Mining Industry	
Support Activities for Mining[a]	33,115.0

a Data were only available for NAICS 213 (Support Activities for Mining) and were not available at the 6-digit NAICS level. The 2002 Economic Census reports 9,104 establishments in NAICS 213.

Source: U.S. SBA, 2007a

3.3.4 FINANCIAL PERFORMANCE

Table 3-6 presents changes in revenue or receipts by industry, in constant dollars. Overall, the water transportation industry experienced a growth of 22 percent over the period 2002–2007, which is more robust than the overall U.S. economy's growth of 15 percent during this period (U.S. BEA, 2011b). There was significant variability in the performance of the various industry sectors, with revenues increasing 106 percent in inland water transportation and 20 percent in deep sea, coastal and Great Lakes water transportation sectors. Port and harbor operations saw a 27 percent decline in revenue, while navigational services to shipping and salvage had a 25 percent increase in revenue over the same period. Coastal and Great Lakes passenger transportation and inland waterways freight transportation saw significant growth, with revenues increasing over 100 percent.

The drilling oil and gas wells sector experienced an increase of almost 115 percent over the same period.

No revenue data were available for the fishing industry in 2007. Instead EPA found data on total value of commercial fish landings in 2007 and used these data as proxy for revenues. Other industry data—employment, payroll—are from the U.S. Small Business Administration and the Census' County Business Patterns dataset because fishing is not included in the Economic Census.

Table 3-6: Revenues by Industry Sector, 2002 and 2007.

Industry Sector	2002 (millions, 2007$)[a]	2007 (millions, 2007$)	Percent Change
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation	$23,778	$28,513	19.9%
Inland Water Transportation	$2,873	$5,934	106.5%
Scenic and Sightseeing Transportation, Water	$1,111	$1,271	14.4%
Support Activities for Water Transportation	$11,296	$12,128	7.4%
TOTAL-Water Transportation	$39,058	$47,845	22.5%
Fishing Industry			
Fishing [b]	$3,646	$4,199	15.2%
Mining Industry			
Drilling oil & gas wells sector	$10,450	$22,512	115.4%

Source: U.S. Census Bureau, 2002b, 2007a; U.S. SBA, 2002b; NOAA, 2011a

[a] 2002 Economic Census revenue data updated to $2007 by using Consumer Price Index (CPI) deflator (US BLS, 2011). All data are in 2007 dollars.

[b] No revenue data are available for the commercial fishing industry in the Economic Census 2007. The 2007 value of fish landing is used as a proxy of revenue for that industry. For consistency, revenues for 2002 are also based on the value of fish landing.

3.4 INDUSTRY MARKET STRUCTURE

The water transportation and fishing industries, and the drilling oil and gas wells segment of the mining industry are comprised of a large number of small businesses, whether classified by employment size or by annual revenues. The vast majorities of firms in these industries employ fewer than 100 people and earn revenues of less than $1 million per year.

This large concentration of small firms earning relatively low amounts of revenue may make the water transportation and fishing industries, and the drilling oil and gas wells segment of the mining industry, more sensitive to changes in operating costs.

3.4.1 FIRMS AND REVENUES

Table 3-7 details the number of firms and revenues by employment size in 2007. Firms not operating the entire year do not report employment data, and are classified under “NR” in the table.

In the water transportation industry, 59 percent of firms employ fewer than 20 people, though these firms only account for 13 percent of the industry’s revenue. Large firms employing more than 500 people, on the other hand, account for only 2 percent of businesses in the industry, but earn a similar share (13 percent) of its revenue.

In the fishing industry, the vast majority of firms (98 percent) employ fewer than 20 people. Less than 0.1 percent of fishing firms employ over 500 people. The share of small firms may be even greater, however, since nonemployer statistics suggest that firms without employees outnumber those with at least one paid employee by a ratio of over 30 to 1 (about 65,000 compared to 2,000).

The drilling oil and gas wells sector also contains a larger percentage of firms employing fewer than 20 people (72 percent), and these firms account for only a small share of total industry revenue (11 percent). The large firms in this sector account for approximately 2 percent of total firms, but earn half of the sector's revenue.

Table 3-7. Firms and Revenues by Employment Size, 2007.

	Number of Firms					Revenues ($1,000) [2]				
Number of Employees	**1-19**	**20-99**	**100-499**	**500+**	**NR[1]**	**1-19**	**20-99**	**100-499**	**500+**	**NR**
Water Transportation										
Deep Sea, Coastal, Great Lakes Water Transportation										
Deep Sea Freight Transportation	125	31	27	5	29	509,454	806,482	3,443,618	1,495,150	37,871
Deep Sea Passenger Transportation	30	3	5	3	7	29,514	-	918,024	11,363,598	1,114
Coastal and Great Lakes Freight Transportation	223	73	40	8	49	696,938	1,139,877	3,565,401	2,787,529	90,748
Coastal and Great Lakes Passenger Transportation	90	27	5	1	41	60,623	255,766	96,847	-	33,615
Inland Water Transportation										
Inland Waterways Freight Transportation	175	55	29	5	52	185912	537,463	1,894,812	1,475,344	70,925
Inland Waterways Passenger Transportation	147	23	6	0	57	96,531	139,284	127,179	D	19,888
Scenic and Sightseeing Transportation, Water										
Scenic and Sightseeing Transportation, Water	933	103	8	2	656	410,068	378,698	D	D	217,917
Support Activities for Water Transportation										
Port and Harbor Operations	150	38	8	1	23	235,284	236,246	288,638	D	16,305
Marine Cargo Handling	129	74	40	19	27	193,590	1,129,606	1,000,772	3,888,876	33,727
Navigational Services to Shipping and Salvage	523	91	24	2	104	541,853	917,516	431,609	D	59,809
Other Support Activities for Water Transportation	534	123	29	45	88	85,910	175,465	101,170	D	21,668
TOTAL-Water Transportation	**3,059**	**641**	**221**	**91**	**1,133**	**3,045,677**	**5,716,403**	**11,868,070**	**3,045,677**	**603,587**
Percentage of Industry	*59%*	*12%*	*4%*	*2%*	*22%*	*13%*	*24%*	*49%*	*13%*	*2%*
Fishing										
Fishing[4]	2,002	37	11	3	--	--	--	--	--	--
Percentage of Industry	*98%*	*2%*	*0.5%*	*0%*	--	--	--	--	--	--
Mining										
Drilling oil & gas wells sector[5]	1,084	178	44	34	164	554,065	957,281	995,244	2,543,388	36,798
Percentage of Sector	*72%*	*12%*	*3%*	*2%*	*11%*	*11%*	*19%*	*20%*	*50%*	*1%*

Source: U.S. Census Bureau, 2007; U.S. SBA, 2007b

Notes: 1. NR = Firms that do not report revenue or employment data because they do not operate the entire year. 2. Revenue data are not complete; some revenue data was not included in data set due to disclosure concerns. 3. D = data withheld to avoid disclosing data for individual companies. 4. Data only include firms with employees, which represent only a small subset of fishing industry establishments. 5. Revenue data for NAICS code 213111 taken from "total value of shipments and receipts for services" representing gross sales.

Table 3-8 details the number of firms according to annual revenue in each sector of the water transportation, fishing, and mining industries. In the water transportation industry, firms earning less than $1 million per year account for 60 percent of the industry's firms, and firms earning between $1 and $5 million account for another 23 percent. A large majority (83 percent) of firms earn revenues less than $5 million.

Table 3-8. Number of Firms According to Revenue Size, 2007.

Revenues (millions of 2007 dollars)	Number of Firms <$1[a]	$1-$5	$5-$25	$25-$100	$100+
Water Transportation					
Deep Sea, Coastal, Great Lakes Water Transp.					
Deep Sea Freight Transportation	65	45	35	25	18
Deep Sea Passenger Transportation	23	5	3	3	7
Coastal and Great Lakes Freight Transportation	126	103	60	30	25
Coastal and Great Lakes Passenger Transportation	71	28	19	5	-
Subtotal-Deep Sea, Coastal, Great Lakes	*285*	*181*	*117*	*63*	*50*
Inland Water Transportation					
Inland Waterways Freight Transportation	104	87	43	18	12
Inland Waterways Passenger Transportation	124	33	16	3	-
Subtotal Inland	*228*	*120*	*59*	*21*	*12*
Scenic and Sightseeing Transportation, Water					
Scenic and Sightseeing Transportation, Water	834	178	31	3	0
Support Activities for Water Transportation					
Port and Harbor Operations	86	81	22	6	2
Marine Cargo Handling	76	77	69	28	12
Navigational Services to Shipping and Salvage	403	142	67	23	5
Other Support Activities for Water Transportation	446	126	46	7	1
Subtotal-Support Activities	*1,011*	*426*	*204*	*64*	*20*
TOTAL-Water Transportation	**2,358**	**905**	**411**	**151**	**82**
Percentage of Industry	*60%*	*23%*	*11%*	*4%*	*2%*
Fishing					
Fishing[4]	1,773	217	47	11	5
Percentage of Industry	*86%*	*11%*	*2%*	*1%*	*0%*
Mining Industry					
Drilling oil & gas wells sector[5]	1,396	310	225	78	50
Percentage of Sector	*68%*	*15%*	*11%*	*4%*	*2%*

Source: U.S. Census Bureau 2007b

[a] The Economic Census breaks down this category further into firms with revenue less than $100,000; $100,000 to $249,999; $250,000 to $499,999; and $500,000 to $999,999.

ND: No data available on distribution of establishments by revenue size

3.4.2 REVENUE BY VESSEL

Data on revenue by vessel are not generally published in national-level data sets. Some statistics are available from public sources, however, regarding per vessel revenue to commercial fishermen in different regions by type of catch or operational configuration. For example, data for California salmon and Dungeness crab fisheries suggest average revenue per vessel ranging from $23,142 for small vessels to $75,715 for medium and large vessels ($25,031 to $81,897 in 2010 dollars) (Hackett and Hansen, 2008). Permit data for Alaska fisheries show similarly wide variability in average revenue per active permit, with larger vessels (60 feet or greater in length) having higher revenue than smaller vessels. Average revenues for 2010 ranged from less than $2,000 for the lower quartile of permits holders for halibut fishing by hand troll, to nearly $2.5 million for the upper quartile of permits holders for king crab fishing (Alaska Commercial Fisheries Entry Commission, 2011). Within each type of Alaskan fishery (catch, type of equipment, or region), the ratios of revenues earned by the top quartile permit holders and those earned by the bottom quartile permit holders can be as high as twenty to one. Revenue to Northeast fishermen using vessels 75 feet and above averaged $790,779 per vessel in 2010 (NOAA, 2011b). The commercial fishing vessels covered by the 2013 VGP are those greater than 79 feet.

Historical data of per vessel revenue for other industry sectors are available from trade publications and industry analysts. For example, Clarkson's ClarkSea Index represents weighted average shipping rates across vessel types for oil tankers (VLCC, Suezmax, Aframax and clean product carriers), dry bulk carriers (Capesize, Panamax, Handymax and Handysize, gas carriers (VLGC) and fully cellular containerships. The index provides an indicator of earnings for principal commercial vessel types. The average index value in 2010 was $15,179 per day per voyage. Historical daily charter rates for the period of 1980-2000 ranged between $5,000 and $22,500 per day (Kite-Powell (2001), cited in USCG (2008), [22] Rates reported in 2006 were about twice these 20-year average values, ranging from $17,000 to $37,500 per day (USCG, 2012a).

3.4.3 SMALL BUSINESSES

The U.S. Small Business Administration (SBA) defines small businesses for the various sectors of these industries as follows (U.S. SBA, 2010)[23]:

- Deep sea, coastal, and Great Lakes water transportation; inland water transportation – fewer than 500 employees
- Scenic and sightseeing transportation; navigational services to shipping and salvage; other support activities for water transportation – revenues less than $7 million
- Port and harbor operations; marine cargo handling – revenues less than $25.5 million
- Fishing – revenues less than $4 million
- Drilling oil and gas wells sector – fewer than 500 employees.

Table 3-9 summarizes the number of small businesses in each sector of the water transportation, fishing, and mining industries, as of 2007. On the whole, all major industries consist of at least

[22] The dollar year is not specified.

[23] These definitions were in effect at the time EPA conducted its analyses.

85 percent small businesses. Inland waterways passenger transportation and coastal and Great Lakes passenger transportation have the highest percentage small businesses with 99 to 100 percent small businesses.

These percentages were calculated based on the number of firms operating the entire year, as employment figures are not available for firms operating only part of the year.

Table 3-9. Small Businesses by Industry Sector.

Industry Sector	Small Business Threshold [a]	Firms Operated Entire Year	Small Businesses	Percent Small Business
Water Transportation Industry				
Deep Sea, Coastal, and Great Lakes Water Transp.				
Deep Sea Freight Transportation	500 Employees	188	183	97.3%
Deep Sea Passenger Transportation	500 Employees	41	38	92.7%
Coastal and Great Lakes Freight Transportation	500 Employees	344	336	97.7%
Coastal and Great Lakes Passenger Transportation	500 Employees	123	122	99.2%
Subtotal-Deep Sea, Coastal, and Great Lakes		*696*	*679*	*97.6%*
Inland Water Transportation				
Inland Waterways Freight Transportation	500 Employees	264	259	98.1%
Inland Waterways Passenger Transportation	500 Employees	176	176	100.0%
Subtotal-Inland		*440*	*435*	*98.9%*
Scenic and Sightseeing Transportation, Water				
Scenic and Sightseeing Transportation, Water	$7 million	1,046	1,020	97.5%
Support Activities for Water Transportation				
Port and Harbor Operations	$25.5 million	197	189	95.9%
Marine Cargo Handling	$25.5 million	262	222	84.7%
Navigational Services to Shipping and Salvage	$7 million	640	560	87.5%
Other Support Activities for Water Transportation	$7 million	626	581	92.8%
Subtotal-Support Activities		*1,725*	*1,511*	*87.6%*
TOTAL-Water Transportation		*3,907*	*3,645*	*93.3%*
Fishing Industry				
Fishing [b]	$4 million	2,053	1,973	96.1%
Mining Industry				
Drilling oil & gas wells sector	500 Employees	2,109	1,893	89.8%

Sources: U.S. Census Bureau, 2007 (from tables: "Number of Firms, Number of Establishments, Employment, Annual Payroll, and Estimated Receipts by Enterprise Employment Size for the United States, All Industries: 2007"; and "Sector 48: Transportation and Warehousing: Subject Series - Estab & Firm Size: Summary Statistics by Revenue Size of Firms for the United States: 2007")

[a] Based SBA definitions of small business at the time EPA conducted its analyses (SBA, 2010).

[b] Includes only employer firms. Nonemployer statistics suggest that the vast majority of firms in the fishing industry earn significantly less than $4 million annually.

3.4.4 EMPLOYMENT AND PAYROLL

Employment in the overall water transportation industry increased by seven percent while employment in the fishing industry declined by 14 percent over the period between 2002 and 2007 (*Table 3-10).* However, total payroll in both industries increased despite the decline in fishing employment numbers. . Employment and payroll in the drilling oil and gas wells sector increased by 76 percent and 108 percent, respectively, over the same period.

Note that these figures, and those discussed in the rest of this section, reflect the detailed data available from the most recent Economic Census (2007) at the time EPA conducted its analyses. They do not capture the impact of the subsequent recession which likely reduced employment and payroll in these sectors, as in many other sectors of the U.S. economy.

TOTAL NUMBER OF EMPLOYEES BY INDUSTRY SECTOR

In 2007, the water transportation industry employed about 157,000 people. Over 40 percent of these people were employed by businesses providing support activities for water transportation. Another third worked in the deep sea, coastal, and Great Lakes water transportation sector, with the remaining 20 percent being split between inland water transportation and scenic and sightseeing transportation on water. The fishing industry employed about 5,600 people in 2007, while the drilling oil and gas wells employed over 106,000 people.

Overall, the water transportation industry saw a 7.3 percent increase in its number of employees between 2002 and 2007. The drilling oil and gas wells sector saw a large (77 percent) increase in employment. The only industry to experience a decline was the fishing industry which had a 14.3 percent decline in employment. Overall, the U.S. unemployment rate decreased from 6.0 percent to 5.0 percent between 2002 and 2007 (U.S. BLS, 2011).[24]

Deep, sea passenger transportation, coastal and Great Lakes passenger transportation, inland waterways freight transportation all experienced large increases in employment, growing by 40 percent or more. These industries also experienced strong growth in revenue, in some cases increasing by over 100 percent from 2002 to 2007. Deep sea freight transportation and inland waterways passenger transportation, other support activities for water transportation and fishing industry had the largest decreases in employment, declining by about 14 percent. All these industries – except for fishing – also experienced declines in revenue, ranging anywhere from 6 to almost 10 percent.

[24] Note that these statistics represent changes between 2002 and 2007, the latest year for which detailed Economic Census data are available. The data pre-date the recession and therefore do not reflect the subsequent drop in overall employment across most sectors of the U.S. economy.

Table 3-10. Employment by Industry Sector, 2002-2007.

NAICS Description	2002 Number of Employees	2007 Number of Employees	% Change
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation			
Deep Sea Freight Transportation	13,083	11,896	-13.8%
Deep Sea Passenger Transportation	11.491	18,210	58.5%
Coastal and Great Lakes Freight Transportation	24,333	22,989	-5.5%
Coastal and Great Lakes Passenger Transportation	2,382	3,303	38.7%
Subtotal-Deep Sea, Coastal, Great Lakes	*52,009*	*56,389*	*8.4%*
Inland Water Transportation			
Inland Waterways Freight Transportation	10,040	16,775	67.1%
Inland Waterways Passenger Transportation	3,277	2,824	-13.8%
Subtotal Inland	*13,317*	*19,599*	*47.2%*
Scenic and Sightseeing Transportation			
Scenic and Sightseeing Transportation, Water	11,557	12,692	9.8%
Support Activities for Water Transportation			
Port and Harbor Operations	5,593	5,987	7.0%
Marine Cargo Handling	37,707	37,358	-0.9%
Navigational Services to Shipping and Salvage	13,157	13,538	2.9%
Other Support Activities for Water Transportation	13,112	11,513	-12.2%
Subtotal-Support Activities	*69,569*	*68,396*	*-1.7%*
TOTAL-Water Transportation	**146,452**	**157,085**	**7.3%**
Fishing Industry			
Fishing	6,537	5,600	-14.3%
Mining Industry			
Drilling oil & gas wells sector	60,450	106,859	76.8%

Source: U.S. Census Bureau, 2002a, 2002b, 2007a, 2007b

PAYROLL BY INDUSTRY SECTOR

The 7 percent increase in employment in the water transportation industry as a whole was accompanied by an 18 percent increase in payroll from 2002 to 2007 (*Table 3-11*). Large increases were seen in deep sea passenger transportation and inland waterways freight transportation which also had large gains in employment. Within the water transportation industry, only inland waterways passenger transportation and other support activities for water transportation had decreases in payroll. These sectors both had some of the largest decreases in employment as well.

The fishing industry's payroll rose by about 4 percent, despite a 14 percent decrease in its employment base.

The payroll for drilling oil and gas sector increased substantially (over 100 percent), reflecting a 76 percent increase in employment in that sector.

Table 3-11. Payroll by Industry Sector, 2002-2007.

NAICS Description	2002 Annual Payroll (millions, 2007$)[a]	2007 Annual Payroll (millions, 2007$)	% Change
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation			
Deep Sea Freight Transportation	$847	$847	0.0%
Deep Sea Passenger Transportation	$513	$838	63.4%
Coastal and Great Lakes Freight Transportation	$1,370	$1,667	21.7%
Coastal and Great Lakes Passenger Transportation	$80	$135	68.9%
Subtotal-Deep Sea, Coastal, Great Lakes	*$2,809*	*$3,486*	*24.1%*
Inland Water Transportation			
Inland Waterways Freight Transportation	$555	$947	70.5%
Inland Waterways Passenger Transportation	$130	$112	-13.9%
Subtotal Inland	*$685*	*$1,059*	*54.5%*
Scenic and Sightseeing Transportation			
Scenic and Sightseeing Transportation, Water	$307	$350	13.8%
Support Activities for Water Transportation			
Port and Harbor Operations	$281	$289	3.1%
Marine Cargo Handling	$1,674	$1,741	4.0%
Navigational Services to Shipping and Salvage	$665	$796	19.6%
Other Support Activities for Water Transportation	$566	$513	-9.5%
Subtotal-Support Activities	*$3,186*	*$3,338*	*4.8%*
TOTAL-Water Transportation	**$6,987**	**$8,233**	**17.8%**
Fishing Industry			
Fishing	$291	$302	3.8%
Mining Industry			
Drilling oil & gas wells sector	$2,871	$5,984	108.4%

Source: U.S. Census Bureau, 2002a, 2002b, 2007; U.S. SBA, 2007b

a 2002 Economic Census revenue data updated to $2007 by using Consumer Price Index (CPI) deflator (US BLS, 2011). All data in $2007.

4 COST OF BEST MANAGEMENT PRACTICES

For this analysis, EPA is estimating the incremental cost of revisions to the 2013 VGP beyond existing conditions, where existing conditions include compliance with the 2008 VGP (i.e., the analysis "baseline").

The first step in assessing costs of the revised VGP permitting requirements consists of determining the population of vessels that will be affected by the Permit. As detailed in *Section 2.1: Domestic Vessel Population*, EPA estimated the total population of domestic vessels to be 58,602, and the total population of foreign vessels to be 14,340. Permit requirements for discharges incidental to the normal operation of a vessel will impact virtually every non-military, non-recreational vessel 79 feet or greater used in a capacity of transportation and entering U.S. territorial waters. However, some vessels will implement only a subset of practices because certain discharges are not applicable to all vessel types. For example, practices associated with graywater discharges are not applicable to barges since this vessel class does not produce this type of discharge. Practices associated with aqueous film-forming foam (AFFF) discharges are only applicable to some utility vessels and to freight and tank ships since other vessel classes do not have a firefighting system. Practices applicable to ballast water management systems are only applicable to the subset of vessels equipped with ballast water tanks. Further, this analysis is concerned exclusively with the *incremental* costs (positive or negative) associated with revisions to the VGP requirements relative to the 2008 VGP and/or other existing regulations and standards of practice. Permit revisions that have the potential to result in incremental costs consist of (1) changes in the universe of vessels covered by the VGP and (2) changes in the practices needing to be implemented by vessel owners to ensure compliance with the Permit.

To estimate the effect of the revised Permit requirements, a baseline must be identified from which to measure this effect. The baseline takes into account previous conditions and determines how the industry would act in the future in the absence of revised Permit requirements. Given that this Permit is not entirely new but instead is revising an existing permit issued in 2008, the baseline for this analysis assumes that all vessels are in full compliance with the 2008 VGP requirements, where such requirements apply to them. Accordingly, the baseline for this analysis is full industry compliance with the 2008 Permit as well as with existing federal and state regulations and with current industry practices or standards that exceed current regulations to the extent that they can be empirically observed.

As noted above, one source of incremental cost relates to changes in the universe of vessels covered by the VGP. An important consideration concerns any expansion to the scope of the VGP to vessel categories. Vessels newly covered by the VGP would have to implement practices to address general categories of discharges, along with any vessel-specific requirement. Because the 2013 VGP covers all commercial fishing vessels 79 feet or greater in length (instead of only those commercial fishing vessels that have ballast water discharges, as was the case for the 2008 VGP), these vessels are newly subject to all applicable practices. Except for cases where the requirements have been revised as part of the 2013 VGP, the costs to owners of the commercial fishing vessels of implementing practices are estimated based on EPA's analysis of the 2008 VGP, but with unit costs restated in 2010 dollars.

A second component of incremental cost relates to substantive changes in effluent limits and related requirements (applicable to all vessels or selected vessel types) or in the recordkeeping, monitoring, reporting, and other general requirements. EPA estimated the impact of the revised requirements per vessel based a review of the changes in vessel practices that may be needed to comply with the revised requirement, industry communications, and research of publicly available information. Additional cost inputs are also derived from conversations with manufacturers and field experts. For each discharge category, EPA estimated the annual per-vessel compliance costs based on the per-instance cost of performing each practice and the number of times per year the practice needs to be performed. Several discharge categories were not analyzed for incremental costs because (1) the industry is already implementing the practices specified in the 2013 VGP or (2) the expected cost of the relevant practice(s) is negligible.

Finally, the total annual cost per discharge category is estimated by multiplying the practice cost per vessel by the number of vessels expected to incur incremental costs due to the revised Permit requirements.

The remainder of this section is organized as follows:

- *Section 4.1* discusses the incremental costs of technology-based effluent limits and related requirements applicable to all vessels. These requirements are contained in Section 2.1 of the VGP.
- *Section 4.2* discusses the incremental costs of practices related to effluent limits and requirements related to 27 discharge categories. These requirements are contained in Section 2.2 of the VGP.
- *Section 4.3* discusses the incremental costs associated with practices applicable to specific vessel types. These requirements are contained in Section 5 of the VGP.
- *Section 4.4* discusses the incremental costs associated with general inspection, monitoring, reporting, and recordkeeping requirements applicable across vessel types. These requirements are contained in Sections 1 and 4 of the VGP.

4.1 TECHNOLOGY-BASED EFFLUENT LIMITS AND RELATED REQUIREMENTS APPLICABLE TO ALL VESSELS

Part 2.1 of the VGP provides general effluent limits designed to apply to all covered vessels for all covered discharge types present on a particular vessel. The practices described in this section are broadly applicable and generally constitute common industry practices for all vessels. They relate to material storage, toxic and hazardous material, fuel spills and overflows, discharges of oil, compliance with other regulations applicable to vessel discharge, and training. With the exception of new general training requirements, the practices contained in the 2013 VGP are unchanged from the 2008 VGP. The new training requirements outlines the responsibilities of the vessel owner to ensure that their crew are adequately trained to implement the terms of the VGP and operate all pollution prevention equipment on board the vessel. The Permit does not require specific, formal training but instead provides flexibility to owners to integrate the necessary information within their existing training program and EPA expects that training on the applicable pollution prevention procedures is already being conducted by all vessels subject to the VGP. Accordingly, this requirement is not expected to represent an incremental burden on vessel owners.

4.2 EFFLUENT LIMITS AND RELATED REQUIREMENTS RELATED TO SPECIFIC DISCHARGE CATEGORIES

The following analysis of practice costs (including per vessel cost and the population of vessels expected to incur additional costs) relies on information collected in support of the 2008 VGP (EPA, 2008a) and additional information EPA obtained from manufacturers and field experts on the incremental costs of revised requirements.

Several of the revised requirements involve a change in customary operating practices that potentially involve additional labor hours and equipment. For practices involving additional labor hours, EPA has used labor rates[25] and hourly estimates developed as part of the 2008 VGP analyses, based on communication with industry representatives, outside research, and other data sources (see EPA, 2008a). EPA obtained cost estimates for additional capital and maintenance expenditures necessary to comply with revised requirements from manufacturers of the relevant equipment. As necessary, one-time costs are annualized using a 7 percent discount rate.

EPA determined the population of vessels to which each practice applies based on information collected in support of the 2008 VGP, EPA's Report to Congress summarizing findings from analyses of discharges incidental to the operation of certain vessels (EPA, 2010b), information submitted to EPA in Notice of Intents (NOIs) received under the 2008 VGP, and other available information on common practices applied by different types of vessels.

The following sections discuss the revised permit requirements, provides estimates of the number of vessels that may incur incremental costs, and summarizes the estimated costs of implementing the practices. The discussion follows the order of the VGP for the 27 discharge categories. For completeness, the discussion covers all 27 discharge categories, including those for which EPA does not expect incremental costs (because the applicable vessels are already implementing and/or the cost of the practice is negligible); discharge categories for which no incremental costs are expected are noted.

[25] Except where otherwise noted, the analysis uses a labor rate of $33.72 when estimating the costs of incremental labor hours. This rate is based on the average labor rate used in the 2008 VGP analysis, which reflects the average across industry sectors based on input from industry representatives (EPA, 2008a). We escalated the labor rate from 2007 to 2010 dollars using the Bureau of Labor Statistics Employment Cost Index (ECI) of 1.067.

4.2.1 DISCHARGES OF DECK WASHDOWN AND RUNOFF AND ABOVE WATER LINE HULL CLEANING

PERMIT REQUIREMENTS

The 2013 VGP requirements for discharge of deck washdown and runoff are fundamentally similar to the 2008 VGP requirements. The revised permit language clarifies that exposed decks must be broom cleaned (or comparable management measures), all existing debris removed before deck washdown, and any deck washdown that may result in a discharge must be conducted with non-toxic and phosphate-free cleaners and detergents.

AFFECTED VESSEL POPULATION

Based on the description of practices within this discharge category, deck washdown and runoff is potentially applicable to all 58,602 vessels. However, 56,276 of the vessels (all vessels with the exception of the newly covered commercial fishing vessels) are already covered by the 2008 VGP and are therefore assumed to be in compliance with the existing requirements in the analysis baseline. Therefore, only commercial fishing vessels will potentially incur incremental costs as a result of the requirement to implement these practices.

The population potentially affected by practices applicable to the deck runoff discharge category is shown in *Table 4-1*.

Table 4-1. Vessel Counts for Practice Applicable to Deck Runoff.

Vessel Class	Total Vessel Count
Commercial Fishing	2,326
Freight Barges	0
Freight Ships	0
Passenger Vessels	0
Tank Barges	0
Tank Ships	0
Utility Vessels	0
TOTAL	**2,326**

COST ESTIMATES

Input from industry representatives on the 2008 VGP requirements suggested that deck cleanup is commonly performed prior to deck washdowns. Also, based on the survey responses, commercial fishing vessels are assumed to already practice deck cleanup as part of standard sanitary practices (e.g., after moving fish to the fish hold).[26]

[26] In the 2008 VGP analysis, EPA assumed that performing cleanup before a deck washdown takes significantly more time as compared to performing cleanup prior to departing from port. Cleanup prior to a deck washdown would entail moving all pieces of machinery and cargo so as to clean the entire deck. However, cleanup prior to departing from port would only require clearing loose items from the deck. Survey responses indicated a wide range of cleanup

Industry input provided on the 2008 VGP also indicated that it is common for all vessels to have drip pans installed for every piece of machinery on deck. The VGP requires that drip pans be onboard the vessel, if feasible, to collect any oily water from machinery and prevent spills. If vessels have drip pans, it is common practice for vessels to perform regular drip pan cleaning and/or draining. However, to capture potential costs to older vessels where such pans are not already provided, EPA performed a sensitivity analysis to examine the potential cost to older commercial fishing vessels that may have to install drip pans and for those that may need to perform cleaning and/or draining.

To evaluate whether the use of phosphate-free cleaners have the potential to impose incremental costs on vessel owners, EPA gathered information on the cost difference between "green" and conventional cleaning products; in particular, EPA compared the cost of phosphate-free and safer/clean products that carry third-party certification with that of conventional cleaning products without such third-party certification. EPA found that there was no systematic cost difference between soaps certified by third parties as more "environmentally friendly" and conventional products; in fact, the certified "green products" were often less expensive. Based on a review of retail prices for 32 unique boat soaps, EPA found that the average per-unit cost of certified cleaners ($20.27/gallon) was slightly less than the average per-unit cost of non-certified, conventional cleaners ($20.98/gallon) (prices taken from West Marine, Jamestown Distributors, Amazon.com and Greenboatstuff.com). Based on these findings, EPA assumes that the VGP requirement to use non-toxic, phosphate-free cleaners does not result in an incremental cost.

SENSITIVITY ANALYSIS

The cost input values are shown in *Table 4-2,* and the estimates/assumptions derived for each practice are described below.

Table 4-2. Per-Vessel Costs for Practices Associated with Deck Runoff

Practice	Labor Hours	Unit Cost	Cost Description
Performing deck cleanup prior to departing from port	0.5	$16.86[a]	Per Instance
Draining and/or wiping and cleaning the drip pans or coamings	1.5	$50.58[a]	Per Instance
Drip pan waste disposal	N/A	$441.98	Per Instance
Installing drip pans or coamings for every piece of machinery on deck	N/A	$178.09	Annualized cost of a One-time Installation

a Unit cost is estimated by multiplying the labor hours by the average hourly labor rate of $33.72.

b Includes cost of $442 per instance to dispose of drip pan waste.

time necessary prior to conducting a deck washdown: from 1 to 6 hours. EPA estimated that it would take 30 minutes to perform cleanup prior to departing from port. (see EPA, 2008a)

Deck Cleanup

- *Average Labor Hours:* EPA has taken the median of 3.5 hours to estimate the time it would take to perform deck cleanup prior to conducting a deck washdown. However, the time requirement to perform cleanup prior to departing from port is assumed to be significantly less: around 30 minutes.
- *Average Labor Rate:* An average labor rate of $33.72 was used. Note that this is greater than the average wage for workers in the commercial fishing industry (based on BLS data for from BLS Occupational and Employment Statistics for code 45-3011 "Fishers and Related Fishing Workers") and may therefore overstate the cost of this practice.
- *Annual Number of Instances:* The number of times that a commercial fishing vessel departs from port is assumed to range from 3 to 6 times per month or more, with an assumed average of 4.5 times per month or 54 times per year. This is based on an average length of fishing trips of 5 to 8 days and is consistent with data from Northeast fisheries that show average trip durations of 7.9 days for groundfish trips and 4.7 days for non-groundfish trips (NOAA, 2011b).
- *Baseline:* Based on industry input during the development of the 2008 VGP, EPA assumes that deck cleanup is currently conducted prior to departing from port by all commercial fishing vessels.

Drip Pan Cleaning

- *Average Labor Hours:* Industry input on the 2008 VGP provided an estimate of 1 to 2 hours required per instance of cleaning, or 1.5 hours on average.
- *Average Labor Rate:* EPA assumed a labor rate of $33.72 per hour.
- *Additional Cost:* EPA assumed an average cost of $442 per drip pan waste disposal, consistent with the cost estimate developed in support of the 2008 VGP (in 2008 dollars, the average costs are $400 with a range of $200 to $1,200 per instance).
- *Annual Number of Instances:* The number of times that a vessel cleans and/or drains its drip pans ranges from 1 to 4 times per month. Given the fact that commercial fishing vessels often only operate part of the year, EPA estimated an average of once per month or 12 times per year.
- *Baseline:* For the low end estimate, EPA assumed that drip pan cleaning is currently practiced 100 percent of the time (or does not apply). For the high end estimate, EPA assumed that cleaning is currently practiced 99 percent of the time (or does not apply).

Installation of Drip Pans/Coamings

- *One-time Installation Cost:* The 2008 VGP analysis assumed an average one-time cost per installation for all machinery on deck of $2,000 in 2008 dollars ($2,210 in 2010 dollars). Annualized over 30 years at a 7 percent discount rate, the cost is $178.09.
- *Baseline:* For the low end estimate, EPA assumed that 100 percent of commercial fishing vessels already have drip pans/coamings installed (or does not apply). For the high end, EPA assumed that 99 percent of vessels already have drip pans/coamings installed or the

requirement does not apply. EPA is assuming that older vessels may need to install drip pans. Thus, the remaining 1 percent of vessels may incur this incremental cost.

The cost per commercial fishing vessel for each practice and the total cost associated with all commercial fishing vessels are presented in *Table 4-3*. As presented in the table, the total annual incremental costs estimated across the population of commercial fishing vessels newly subject to the permit requirements ranges from $0 to $141,627.

Table 4-3. Deck Runoff Sensitivity Analysis.

Practice and Vessel Class	Vessel Count	% Vessels Assumed to Incur Incremental Cost	Annual Cost per Vessel[a,b]	Total Annual Cost
Low End Estimate				
Deck Cleanup	2,326	0%	$0.00	$0
Drip Pan Cleaning	2,326	0%	$0.00	$0
Installation of Drip Pans/Coamings	2,326	0%	$0.00	$0
Low End Total				**$0**
High End Estimate				
Deck Cleanup	2,326	0%	$0.00	$0
Drip Pan Cleaning	2,326	1%	$59.11	$137,484
Installation of Drip Pans/Coamings	2,326	1%	$178.09	$4,142
High End TOTAL				**$141,627**

a Drip pan cleaning is assumed to occur 99% or 100% of the time (high and low end estimates, respectively).

b Cost for the installation of drip pans/coamings is annualized at a 7 percent discount rate over 30 years.

4.2.2 DISCHARGES OF BILGEWATER

The VGP reinforces several of the requirements of the Act to Prevent Pollution from Ships (APPS), the U.S. implementation of the 1973/78 International Convention for the Prevention of Marine Pollution from Ships (MARPOL), regarding discharges of oily bilgewater. Additionally, the VGP prohibits the discharge of bilgewater by vessels weighing more than 400 gross tons within 1 nm of shore except during emergencies. These Permit requirements complement current requirements found in the USCG regulations governing Oily Mixture (Bilge Slops) Discharges on Oceangoing Ships Over 400 Tons, implemented under the authority of APPS and last amended in 1999. These regulations require the use of oily-water separators on discharges of bilgewater by vessels larger than gross 400 tons (33 CFR 155).

VGP requirements consistent with APPS do not impose any additional costs on subject operators.

PERMIT REQUIREMENTS

The 2013 VGP bilgewater permit requirements build upon the 2008 VGP requirements by retaining general practices related to the minimization of bilgewater discharges. The 2013 VGP specifies additional requirements for discharges of treated bilgewater into waters subject to the Permit. In the 2013 VGP, vessels weighing more than 400 gross tons that regularly sail the territorial sea (at least once per month) must discharge treated bilgewater outside 1 nm of shore, if technologically feasible, and may discharge treated bilgewater between 1 nm and 3 nm from shore only if they are sailing at speeds greater than 6 knots. Discharges of treated bilgewater are prohibited within 1 nm from shore.[27] The VGP provides exceptions for circumstances where holding bilgewater or discharging in accordance with Permit conditions) would threaten the safety and stability of the ship. Discharges within 1 nm from shore or made for safety reason must be documented as part of the requirements in Part 4.2 of the VGP and reported in the Annual Report.

The 2013 VGP also specifies annual monitoring requirements for vessels greater than 400 gross tons that discharge bilgewater into waters subject to the Permit and were built on or after December 1, 2013. Vessels can conduct reduced monitoring if they: (1) use a separator capable of meeting a 5 ppm limit and set an alarm to prevent discharge of bilgewater above that limit in waters subject to the Permit; (2) they calibrate the oil content monitor at least annually; and (3) the oil content monitor never reads above 5 ppm during discharges into waters subject to the Permit). For all other vessels greater than 400 gross tons which discharge into waters subject to the permit, analytical sampling must be conducted annually.

Permit Text (Excerpt):

All bilgewater discharges must be in compliance with the regulations in 40 CFR Parts 110 (Discharge of Oil), 116 (Designation of Hazardous Substances), and 117 (Determination of Reportable Quantities for Hazardous Substances) and 33 CFR §151.10 (Control of Oil Discharges). In addition:

- *Vessel operators may not use dispersants, detergents, emulsifiers, chemicals, or other substances that remove the appearance of a visible sheen in their bilgewater discharges. This requirement does not prohibit the use of these materials in machinery spaces for the purposes of maintaining or cleaning equipment.*
- *Except in the case of flocculants or other required additives (excluding any dispersants or surfactants) used to enhance oil/water separation during processing (after bilgewater has been removed from the bilge), vessel operators may not add substances that drain to the bilgewater that are not produced in the normal operation of a vessel. The use of oil solidifiers, flocculants, or other required additives are allowed only as part of an oil water separation system provided they do not alter the chemical make-up of the oils being discharged and any discharge of such materials into waters subject to this permit must be minimized. Routine cleaning and maintenance activities associated with vessel equipment and structures are considered to be normal operation of a vessel if those practices fall within normal marine practice.*
- *All vessels must minimize the discharge of bilgewater into waters subject to this permit. This can be done by minimizing the production of bilgewater, disposing of bilgewater on*

[27] This is a change from the 2008 VGP which authorized the discharge of treated bilgewater within 1 nm from shore from vessels greater than 400 gross tons that use an oily water separator that limits oil content to 5 ppm.

shore where adequate facilities exist, or discharging into waters not subject to this permit (i.e., more than 3 nautical miles [nm] from shore) for vessels that regularly travel into such waters. Though not regulated under this permit, EPA notes that discharges of bilgewater outside waters subject to this permit (i.e., more than 3 nm from shore) are regulated under Annex I of the International Convention for the Prevention of Pollution from Ships as implemented by the Act to Prevent Pollution from Ships and U.S. Coast Guard regulations found in 33 CFR part 151.

- *Vessels greater than 400 gross tons shall not discharge untreated oily bilgewater (i.e., bilgewater not treated with an onboard separator or bilgewater with a concentration of oil greater than 15 ppm) into waters subject to this permit.*
- *Vessels greater than 400 gross tons that regularly sail outside the territorial sea (at least once per month) shall not discharge treated bilgewater within 1 nm of shore if technologically feasible (e.g., holding would not impact safety and stability, would not contaminate other holds or cargo, or would not interfere with essential operations of the vessel). Any discharge which is not technologically feasible to avoid must be documented as part of the requirements in Part 4.2 and reported to EPA as part of the vessel's annual report.*
- *Vessels greater than 400 gross tons shall not discharge treated bilgewater into waters referenced in Appendix G unless the discharge is necessary to maintain the safety and stability of the ship. Any discharge of bilgewater into these waters must be documented as part of the recordkeeping requirements in Part 4.2 and reported to EPA as part of the vessel's annual report.*
- *For vessels greater than 400 gross tons that regularly sail outside the territorial sea (at least once per month), if treated bilgewater is discharged into waters subject to this permit, it must be discharged when the vessel is underway (sailing at speeds greater than 6 knots), unless doing so would threaten the safety and stability of the ship. EPA notes that vessel operators may also choose to dispose of bilgewater on shore where adequate facilities exist. Any discharge which is made for safety reasons must be documented as part of the requirements in Part 4.2 and reported to EPA as part of the vessel's annual report*.

2.2.2.1 Bilgewater Monitoring

"New Build" vessels built after December 1, 2013 greater than 400 gross tons that may discharge bilgewater into waters subject to this permit must monitor (i.e., sample and analyze) their bilgewater effluent at least once a year for oil and grease content . That monitoring can be conducted as part of the vessel's annual survey.

To demonstrate treatment equipment maintenance and compliance with this permit, the bilgewater sample must be analyzed for oil by either Method ISO 9377-2 (2000) Water Quality–Determination of hydrocarbon oil index–Part 2: Method Using Solvent Extraction and Gas Chromatography (incorporation by reference, see 46 CFR § 162.050–4) or EPA Method 1664. At the time of sample collection, the reading on the oil content meter (OCM) must be recorded such that the oil and grease concentration measured by the laboratory can be compared to the OCM. .

If your analytical results show oil and grease concentrations of less than 5 ppm for two consecutive years, you need not sample and analyze subsequent years of permit coverage if:

- *Your vessel uses an oily water separator capable of meeting a 5 ppm oil and grease limit, or you use an alarm which prevents the discharge of oil and grease above 5 ppm whenever you discharge in waters subject to this permit,*
- *You calibrate your OCM at least annually (calibrations during a vessel survey meet this requirement), and*
- *Your OCM never reads above 5 ppm during discharges into waters subject to this permit. If this information is recorded in the oil record book, you need not record these data in other recordkeeping documentation.*

Records of monitoring must be retained onboard for at least 3 years in the vessel's recordkeeping documentation and must include:

- *The date, exact place, and time of sampling or measurements;*
- *The individual(s) who performed the sampling or measurements;*
- *The individual(s) who performed the analyses and any meter recalibration;*
- *The techniques or methods used for sample analyses*
- *The results of such analyses and OCM readings.*

2.2.2.2 Monitoring Reporting

For those vessels for which monitoring must be conducted, analytical and corresponding OCM monitoring data must be submitted at least once per calendar year no later than February 28 of the year after the data are collected. Additionally, if you have met the requirements in part 2.2.2.1 to waive analytical monitoring after two years, you must note your waiver qualifications on your report. Data may be submitted as part of the vessel's annual report (Appendix H) on the VGP bilgewater DMR.

Current regulation of oily bilgewater discharges from vessels is based on Annex I of the International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78). Under MARPOL, all ships over 400 gross tons are required to have equipment installed onboard that limits the discharge of oil into the oceans to 15 ppm when a ship is en route. All vessels over 400 GT are also required to have an oil content monitor (OCM), including a bilge alarm, integrated into the piping system to detect whether the treated bilgewater that is being discharged from the bilge separator meets the discharge requirements. Some countries have bilge discharge requirements that are stricter than the international 15 ppm standard. For example, the *Canadian Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals* requires 5 ppm bilge alarms for Canadian-flagged vessels which discharge treated bilgewater in the Great Lakes.

Bilge separators, oil content meters and bilge alarms are certified by the Coast Guard to meet 46 CFR 162 (MARPOL Annex I implementing regulations). Type approval is based on testing of manufacturer-supplied oil pollution control equipment by an independent laboratory, in accordance with test conditions prescribed by the Coast Guard (33 CFR 155 and 157 and 46 CFR 162). In conformance with IMO resolution MEPC.108(49), the measurement of oil (petroleum products or hydrocarbon, HC) in bilge separator effluent must be analyzed using ISO method 9377-2:2000[28] or equivalent.

The 2013 VGP is largely consistent with requirements already in place under MARPOL. The only potential incremental costs for the 2103 VGP is associated with 1) annual monitoring and analytical sampling for newly built vessels over 400 gross tons that regularly sail outside the territorial sea and discharge bilgewater to waters subject to the Permit (between 1 nm and 3 nm from shore), and 2) documentation of bilgewater discharges within 1 nm from shore or made necessary by ship safety or stability, for these same vessels.

Table 4-4 summarizes the changes in requirements applicable to different categories of vessels and their potential cost implications. Note that all vessels would continue to have the option to hold their bilgewater, if they have the requisite storage capacity.

[28] This analytical method is "Water quality -- Determination of hydrocarbon oil index -- Part 2: Method using solvent extraction and gas chromatography".

Table 4-4. Summary of the Potential Implications of Revised Bilgewater Discharge Requirements under Consideration

Vessel / 2008 VGP Conditions	2013 VGP	Potential Cost implications [a]
	Within 1 nm	
Vessels 400 gross tons or less		
• Hold	• No Change	• None
• Discharge	• No Change	• None
Vessels greater than 400 gross tons		
• Hold	• No Change	• None
• Discharge treated bilgewater (treated to 15 ppm) only if not *technologically feasible to hold*	• No Change	• None
	Within 1-3 nm	
Vessels 400 gross tons or less		
• Hold	• No Change	• None
• Discharge	• No Change	• None
Vessels greater than 400 gross tons		
• Hold	• Hold	• None
• ≥ 6 knots: Treat to 15 ppm and monitor using oil content monitor	• ≥ 6 knots: Discharge treated bilgewater (treated to 15 ppm or less). Monitor and conduct annual analytical sampling[a]	• Cost of annual analytical sampling and reporting if vessel was built after December 1, 2013[a]
• < 6 knots: Discharge bilgewater (treated to 15 ppm) only if threatens safety and stability	• < 6 knots: Discharge treated bilgewater (treated to 15 ppm or less) only if threatens safety and stability	• None

[a] Costs may be less for vessels equipped with separators capable of meeting 5 ppm and that meet performance requirements for this treatment level.

VESSEL POPULATION POTENTIALLY AFFECTED BY OPTION

As indicated above, the 2013 VGP may result in incremental costs for certain newly built vessels greater than 400 gross tons that discharge treated bilgewater within waters subject to this Permit, namely monitoring, analytical sampling, and reporting costs. For the purpose of estimating the number of vessels that may incur incremental costs, EPA used information on the number of new vessels greater than 400 gross tons that may become operational during the period of the permit.

The MISLE database indicates that a total of 47,148 vessels weigh more than 400 gross tons. Data from NOIs submitted to EPA as of August 2010 show that about 4 percent of vessels larger than 300 gross tons use an onboard bilgewater treatment system (the fraction of vessels vary among the vessel classes with a majority of oil and gas tankers and medium and large cruise ships reporting the use of an onboard treatment system for their oily water or bilgewater discharges).[29] Thus, EPA assumes that 1,711 vessels greater than 400 gross tons currently treat their bilgewater (728 utility vessels, 470 freight ships, 199 tank ships, etc.).

[29] The NOI data are self-reported and may under represent the number of vessels that have a bilge water treatment system onboard.

As summarized in *Section 3.3: Recent Trends*, the number of vessels in the domestic fleet has been relatively flat in recent years, or has even seen declines in certain types of vessels. For the purpose of this analysis, EPA assumes that the future vessel population will remain relatively unchanged over the permit period. Using an assumed life of 30 years, approximately 1/30th of the vessel fleet may be replaced in any given year, or 1,572 vessels greater than 400 gross tons. Based on NOI data for the 2008 VGP, EPA further assumes that 4 percent of the new vessels constructed on or after December 19, 2013 will opt to treat their bilgewater to the required effluent limits, with the fraction of vessels ranging by vessel types from about 1 percent for barges to over 70 percent for freight ships and tank ships, consistent with characteristics of existing vessels. EPA conservatively assumes that as non-treating vessels are replaced, they will be twice as likely to treat bilgewater as otherwise similar existing vessels, which would increase by 59 the number of vessels that treat their bilgewater for each year of the permit.

The population of existing and vessels potentially affected by practices applicable to bilgewater discharge category is shown in *Table 4-5.* The table includes the estimated number of new vessels coming into service each year.

Table 4-5. Vessel Counts for Practices Applicable to Option to Authorize Discharge of Treated Bilgewater (to 5 ppm).

Vessel Class	Percentage of Vessels with Onboard Bilgewater Treatment[a]	Total Existing Vessels with Onboard Bilgewater Treatment	Incremental New Vessels with Onboard Bilgewater Treatment (per Year)[b,c]	Incremental New Vessels with Onboard Bilgewater Treatment (at Year 5)
Commercial Fishing	27%	111	5	27
Freight Barges	0%	31	2	10
Freight Ships	71%	470	6	32
Passenger Vessels	40%	109	4	22
Tank Barges	1%	63	4	21
Tank Ships	71%	199	3	14
Utility Vessels	29%	728	34	171
TOTAL		**1,711**	**59**	**297**

a Based on NOI data on onboard treatment systems and waste streams generated aboard vessels.

b The U.S. Coast Guard estimates that there are approximately 86 new oceangoing vessels built per year (70 FR 67066).

c Represents the incremental number of new vessels assumed to treat their bilgewater (replacement of non-treating vessels with treating vessel).

COST ESTIMATES FOR OPTION

The cost of complying with the bilgewater requirements includes costs for the oil discharge monitoring system, overboard discharge control system, monitoring, sampling, maintenance, and reporting.[30] Since EPA assumes that existing vessels will continue to use current practices (treat or hold, depending on the vessel), these costs are not incremental costs of complying with the revised VGP.

Sampling and Testing

The Permit specifications call for annual sampling and analytical testing of the bilgewater effluents to verify oil content. While some vessels may be already conducting such monitoring as part of their operations, for the purpose of this analysis, EPA assumed that this activity is fully attributable to the 2013 VGP. EPA estimated the cost associated with bilgewater sampling by assuming that sample preparation and administrative activities associated with the collection and processing of the sample range between 2 and 3 hours for each sampling event. Laboratory costs and incidentals such as shipping were assumed to be $300 per sampling event.[31]

Reporting

Under the option under consideration, vessel owners must submit data on their compliance with bilgewater discharge and treatment standards as part of their annual reporting to EPA. The bilgewater discharge reporting requirement is largely unchanged from the 2008 VGP. Any incremental burden of adding information on analytical sampling results to the existing annual report is assumed to be negligible.

SENSITIVITY ANALYSIS

EPA estimated the potential incremental costs to vessel owners using the cost input values presented above and the following assumptions.

Testing Costs

- *Applicable vessels*: The estimated vessel counts above indicate the number of newly built vessels expected to be equipped with bilgewater treatment systems, but this does not

[30] Representatives from equipment manufacturers suggested that treatment systems can be retrofitted onto existing vessels. They described the process as straightforward and requiring only minimal input from engineers. However, they also noted that the retrofit can be time-intensive. The process involves a site survey and usually requires the vessel owner to contract an electrician, pipe-fitter, and welder. More experts may be required depending on the vessel, and often coordinating their efforts can be difficult. The American Bureau of Shipping (ABS) must approve the final installation. One representative suggested that the process can take anywhere from 1.5 to 3 weeks, though another noted that, with efficient coordination of labor, the process can take as little as two days.

[31] We contacted laboratories to get quotes for conducting testing using method ISO 9377-2(2000) Water Quality-Determination of hydrocarbon oil—Part 2: Method using solvent extraction and gas chromatography. While we were able to obtain information on reactant costs (about $100/analysis), these costs do not include the technician rates or overhead. For the purpose of this analysis, we assumed that each analysis costs $250. We assumed an additional $50 for shipping and other incidentals.

necessarily mean that all such vessels will discharge within waters subject to this Permit and will need to meet the discharge requirements. Vessels may hold their bilgewater until they are in an area where they may discharge or may dispose of bilgewater on shore where adequate facilities exist. EPA could not find data on the fraction of vessels that discharge treated bilgewater within 1 nm to 3 nm from shore. For the purpose of this analysis, EPA assumed that between 40 percent (low bound estimate) and 80 percent (high bound estimate) of vessels greater than 400 gross tons discharge treated bilgewater within 1 nm to 3 nm from shore. This is consistent with EPA's understanding that oceangoing vessels do not typically discharge in territorial seas. EPA further assumed that all barges equipped to treat bilgewater would discharge within 3nm from shore. This results in an average of 82 to 145 vessels potentially incurring incremental costs for the low and high bound estimates, respectively (27 to 49 vessels in Year 1, growing to 137 to 244 vessels by Year 5).

- *Implementation rate*: All newly built vessels assumed to use a bilgewater treatment system will have to conduct annual sampling and analytical testing. This implementation rate overstates the number of vessels that will have to conduct sampling and analytical testing annually since newly built vessels that can demonstrate performance at the 5 ppm level may only need to conduct sampling and analytical testing as few as once during their 5-year permit.[32] Owners of vessels capable of meeting the 5 ppm treatment levels have an incentive to avoid unnecessary sampling and analytical testing.
- *Incremental costs*: Each sampling event is assumed to involve 2 to 3 hours of labor (low and high bound estimates, respectively) and $300 in laboratory and incidental costs.

The estimated cost per vessel for each practice and the total cost associated with all vessels are summarized in *Table 4-3*.

[32] While such vessels would need to calibrate their oil content monitor at least annually, EPA understands that this calibration is already conducted in accordance with manufacturers' recommendation.

Table 4-6. Bilgewater Treatment Sensitivity Analysis.

Vessel Class	Number of Vessels Treating Bilgewater	Percentage of Vessels Discharging within 3 nm from Shore	Annual Cost per Vessel[a]	Total Annual Cost
Low End Estimate				
Annual Sampling and Analytical Testing [a]				
Commercial Fishing	16	40%	$367.44	$2,352
Freight Barges	6	100%	$367.44	$2,205
Freight Ships	19	40%	$367.44	$2,793
Passenger Vessels	13	40%	$367.44	$1,911
Tank Barges	12	100%	$367.44	$4,409
Tank Ships	8	40%	$367.44	$1,176
Utility Vessels	103	40%	$367.44	$15,139
Low End Total		**82 vessels**		**$29,983**
High End Estimate				
Annual Sampling and Analytical Testing [a]				
Commercial Fishing	16	80%	$401.17	$5,135
Freight Barges	6	100%	$401.17	$2,407
Freight Ships	19	80%	$401.17	$6,098
Passenger Vessels	13	80%	$401.17	$4,172
Tank Barges	12	100%	$401.17	$4,814
Tank Ships	8	80%	$401.17	$2,567
Utility Vessels	103	80%	$401.17	$33,056
High End Total		**145 vessels**		**$58,249**

a Annual sampling and analytical testing is assumed to apply to all vessels that will discharge treated bilgewater in waters subject to this Permit.

4.2.3 DISCHARGES OF BALLAST WATER

The 2013 VGP complements USCG requirements under the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA), as reauthorized and amended by the National Invasive Species Act of 1996 (NISA), regarding the impacts of discharges from ballast water treatment systems (BWTS).

The 2013 VGP specifies performance standards for BWTS, along with associated monitoring, sampling, testing, and recordkeeping. The requirements are applicable to all vessels that operate in U.S. waters and are equipped with ballast water tanks, unless they are in innocent passage, vessels of the armed forces[33], and vessels that operate exclusively in one Captain of the Port Zone.

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[33] Vessels of the armed forces are subject to the Uniform National Discharge Standards for Vessels of the Armed Forces (33 U.S.C. 1322(n))

The BWTS performance standards are consistent with the “Phase One” standards finalized by USCG in 2012 under 33 CFR part 151 and 46 CFR part 162 (74 FR 44632).

The VGP-specific monitoring and recordkeeping include sampling and analytical testing of the BWTS effluent and reporting of the results of these tests in an annual report to EPA. While the additional monitoring and testing requirements will impose additional costs on most subject vessel operators, the requirements consistent with BWTS under USCG regulations will not.

PERMIT REQUIREMENTS

The 2013 VGP ballast water requirements build upon the 2008 VGP requirements and USCG regulations. The 2013 VGP identifies four ballast management methods available to vessels: (1) on-board treatment, (2) onshore treatment; (3) use of public water supply; and (4) no discharge in regulated waters. It also provides for specific requirements for vessels that treat their ballast water and enter the Great Lakes.

<u>Permit Text (Excerpt):</u>

2.2.3.5.1 Ballast Water Management Measures

In addition to the other requirements of this permit, owner/operators of vessels subject to the numeric discharge limits in Part 2.2.3.5 of this permit must meet those limits. Vessel owner/operators may use one of the four following ballast water management methods to meet the numeric discharge limits in Part 2.2.3.5:

2.2.3.5.1.1 Ballast Water Management using a Ballast Water Treatment System

Vessel owner/operators utilizing a ballast water treatment system (BWTS) must use a system which has been shown to be effective by testing conducted by an independent third party laboratory, test facility or test organization. A system that has been type approved by the U.S. Coast Guard under 46 CFR Part 162.060 or received “Alternative Management System” designation by the U.S. Coast Guard under 33 CFR 151.2026 will be deemed to meet this “shown to be effective” provision. Once the effluent limits in Part 2.2.3.5 become applicable to a vessel (see part 2.2.3.5.2 for applicability timeframes for specified categories of vessels), owners/operators of vessels utilizing a ballast water treatment system to meet the requirements of Part 2.2.3.5 of this permit must meet those limits as an instantaneous maximum.

Additionally, following installation of a BWTS, the master, owner, operator, agent, or person in charge of the vessel must maintain the BWTS in accordance with all manufacturer specifications. Furthermore, all treatment must be conducted in accordance with the BWTS manufacturer’s instructions. The BWTS must be used prior to any discharge of ballast water to waters of the U.S, either at uptake, in tank, or during discharge according to the treatment system manufacturer’s instructions.

2.2.3.5.1.1.1 Monitoring From Vessels Using Ballast Water Treatment Systems

The monitoring requirements in Part 2.2.3.5.1.1 apply to ballast water discharges from vessels employing ballast water treatment systems that are used to achieve the effluent limitations of Part 2.2.3.5. The monitoring is divided into three components. The first, in Part 2.2.3.5.1.1.2, is *required of all vessels and generally requires monitoring equipment performance to assure the system is fully functional. Vessels conducting this monitoring also must adequately calibrate their equipment as required in Part 2.2.3.5.1.1.3. The second component, in Part 2.2.3.5.1.1.4 requires monitoring from all ballast water systems for selected biological indicators. The third component, in part 2.2.3.5.1.1.5 requires monitoring of the ballast water discharge itself for biocides and residuals to assure compliance with the effluent limitations established in part 2.2.3.5 of the permit, as applicable.*

2.2.3.5.1.1.2 Ballast Water System Functionality Monitoring

Ballast water treatment systems use physical and/or chemical processes, or a combination thereof, to achieve reductions in living organisms. The use of physical/chemical indicators of treatment performance verifies that the ballast water treatment system is operating according to the manufacturers' operating specifications. To assess the BWTS functionality, monitoring indicators of the BWTS functionality is required at least once per month for specific parameters that are applicable to your system. The required parameters to be monitored, with appropriate monitoring approaches are contained in Appendix J. For example, if your system uses a filter and chlorine dioxide, you must meet the requirements for systems using both filters and chlorine dioxide. If your system uses cavitation, UV, and hypochlorite generation, you must monitor conditions for all three treatment units. EPA expects that most ballast water treatment systems will make use of at least two physical and/or chemical processes.

Most ballast water treatment systems have control and self diagnostic equipment such as sensors that continuously measure treatment parameters to verify performance. The metrics to be monitored are based on common approaches used in ballast water treatment systems. As new approaches become commonly available, EPA will develop new monitoring parameters as appropriate.

2.2.3.5.1.1.3 Ballast Water monitoring equipment calibration

At a minimum, all applicable sensors and other equipment must be calibrated annually. Additionally, all applicable sensors and other control equipment must be calibrated no less frequently than recommended by the sensor or other equipment manufacturer, or by the ballast water treatment system manufacturer or when warranted based on device drift from a standard or calibrated setting. EPA expects many sensor types (e.g., pH probes, TRO sensors, turbidity sensors) will need to be calibrated on a more frequent basis. Calibration of the sensors and equipment can be conducted on-board the vessel or they can be removed and shipped to the manufacturer or other vendor for calibration. During the period when the sensors are not installed (or otherwise inoperable thus significantly compromising the performance of the ballast water treatment system), the vessel must not discharge ballast water.

2.2.3.5.1.1.4 Effluent Biological Organism Monitoring

Once a ballast water treatment system is required to be installed onboard a vessel (see part 2.2.3.5.2 for applicability and timeframe for installation of such vessels), any ballast water discharges from such vessels will be subject to the effluent limitations in Part 2.2.3.5 of this permit. To ascertain compliance with the effluent limitation in that section, EPA is establishing the following biological indicator compliance monitoring. These samples can be taken by collecting a small volume sample from the ballast water discharge (consistent with the sampling *guidance found in EPA's Generic Protocol for the Verification of Ballast Water Treatment Technology) and analyzing the sample for concentrations of certain biological indicator parameters. Analysis of concentrations of indicator organisms must include monitoring for the parameters in Table 2 below utilizing the methods in that table, or other EPA Part 136 methods as applicable.*

[Table 2: Indicator Organism Monitoring Parameters]

Biological indicator compliance monitoring sampling of ballast water effluent must be conducted 2 times during the first year the system is installed or used for vessels with devices for which high quality data are available. For vessels with high quality data, if sampling results are below permit limits for two consecutive events, the vessel owner/operator may reduce monitoring to one time per year after the first year. However, if the vessel owner/operator exceeds a permit limit on any sampling event, they must return to monitoring two times per year until they have two additional results below permit limits. For vessels for which high quality data are not available, monitoring must be conducted 4 times per year. For all vessels, one of those samples may be conducted as part a vessel's annual or other survey, and during the first year, one of those sampling events may be conducted as part of the installation of the system to ensure it is functioning properly. Records of the sampling and testing results must be retained onboard for a period of 3 years in the vessel's recordkeeping documentation consistent with Part 4.2. Each sample must be tested independently and the individual results must be reported and not averaged. Monitoring must be conducted at least 14 days apart from different discharge events.

Devices for which high quality data are available means either:

a) any ballast water treatment system type approved by the United States Coast Guard under 46 CFR Part 162.060 or granted alternate management system status by the US Coast Guard under 33 CFR 151.2026; or

b) any ballast water treatment system:

i. type approved by a foreign administration;

ii. for which efficacy testing was conducted by an independent third party testing organization, either in accordance with the ETV protocol or in a manner consistent with the ETV protocol with respect to QA/QC procedures, the use of validated methods including appropriate volumes of representative samples, and full description and documentation of test procedures, results and analyses; and

iii. all Active Substance or Biocide data (e.g., the full data package as submitted to the International Maritime Organization for approval) have all been made available to the US EPA.

2.2.3.5.1.1.5 Requirements and Effluent Limitations for BWTS that use Active Substances (e.g., biocides)

2.2.3.5.1.1.5.1 Authorization of Residual Biocides Associated with Ballast Water Treatment Systems

Many ballast water treatment systems produce or use biocides as an agent to reduce living organisms present in the ballast water tank. In order to be eligible for coverage under this *permit, any ballast water treatment system must not use any biocide that is a "pesticide" within the meaning of the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C § 136 et seq.) unless that biocide has been registered for use in ballast water treatment under such Act. The requirement in the preceding sentence does not apply if such biocide is generated solely by the use of a "device" on board the same vessel as the ballast water to be treated by the biocide, as the term "device" is defined in the Federal Insecticide, Fungicide, and Rodenticide Act. In addition, if the ballast water treatment system uses or generates biocides and you will discharge ballast water treated with biocides into waters subject to this permit, you must meet one of the following conditions to be eligible for permit coverage.*

The discharge of biocides or residuals may not exceed the following instantaneous maximum limits expressed as micrograms per liter (µg/l).

[Table 3. Maximum Ballast Water Effluent Limits for Residual Biocides]

Any other biocides or derivatives may not exceed acute water quality criteria listed in EPA's 2009 National Recommended Water Quality Criteria, and any subsequent revision, at the point of ballast water discharge. This document can be found at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/upload/nrwqc-2009.pdf. Tables summarizing the subsequent revisions can be found at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/. Discharges of biocide residuals or derivatives must also meet monitoring requirements under Part 2.2.3.5.1.1.1, and reporting and recordkeeping requirements in Part 2.2.3.5.1.1.6.

If the biocide used or produced by your system and its derivatives is not listed in the previous table or found in EPA's National Recommended Water Quality Criteria, you must notify EPA at least 120 days in advance of its use and provide any associated aquatic toxicity data for that biocide or its derivatives of which you are aware. EPA may impose additional limitations on a treatment system-specific basis, or require you to obtain coverage under an individual permit, if necessary. EPA may inform the vessel owner/operator of specific requirements. You may also seek coverage under an individual NPDES permit pursuant to Part 1.8.2 of this permit. You may not discharge the biocide at issue until you receive a response from EPA to your notification.

2.2.3.5.1.1.5.2 Residual Biocide and Derivative Monitoring

For vessels subject to Part 2.2.3.5.1.1.1, you must conduct monitoring of the vessel ballast water discharge for any residual biocides or derivatives used in the treatment process, in part to demonstrate compliance with the conditions in Part 2.2.3.5.1.1.5.1. For instance, if chlorine is the biocide used in the ballast water treatment, you must test for residual chlorine in the vessel ballast water discharge to see if it complies with the standards in Part 2.2.3.5.1.1.5.1.

In order to demonstrate that residual biocides or derivatives are in compliance with this permit, that substantial quantities of harmful byproducts are not produced, and provide EPA with needed information about system functionality, the vessel operator initially must take samples according to the following:

[Table 4: Monitoring Schedule for Residual Biocides or Derivatives of the Residual Biocide]

Devices for which high quality data are available means either:

a) any ballast water treatment system type approved by the United States Coast Guard under 46 CFR Part 162.060 or granted alternate management system status by the US Coast Guard under 33 CFR 151.2026; or

b) any ballast water treatment system: i) type approved by a foreign administration; ii) for which efficacy testing was conducted by an independent third party testing organization, either in accordance with the ETV protocol or in a manner consistent with the ETV protocol with respect to QA/QC procedures, the use of validated methods including appropriate volumes of representative samples, and full description and documentation of test procedures, results and analyses; and iii) all Active Substance or Biocide data (e.g., the full data package as submitted to the International Maritime Organization for approval) have all been made available to the US EPA.

Each sample must be tested independently and the individual results must be reported and not averaged. Samples must be tested as soon as possible after sampling, and may not be held longer than recommended for each tested constituent as given in 40 CFR Part 136. Sampling and testing shall be conducted using a sufficiently sensitive method according to 40 CFR Part 136 or may use an alternate method if allowed in Table 5 below.

[Table 5. Residual Biocides and Biocide Derivative Monitoring Requirements]

2.2.3.5.1.1.6 Ballast Water Treatment System Recordkeeping and Reporting

Records of sampling and testing results required under Part 2.2.3.5.1.1 must be retained onboard for a period of three years in the vessel's recordkeeping documentation. Vessels must also submit the testing results to EPA as part of the vessel's annual report (Appendix H) on the VGP ballast water DMR.

Records of monitoring information shall include:

- *The ballast water treatment system used, any type approval certificate, and records of whether the system meets the high quality data criteria as stated in part 2.2.3.5.1.1.4 (a) or (b);*
- *The individual(s) who performed the sampling, measurements, and/or inspections;*
- *The date(s) analyses and/or inspections were performed;*
- *Any sensor or other control equipment calibration and functional tests conducted during the inspection as applicable;*
- *The techniques or methods used for any sensor or other control equipment calibration and functional tests as applicable;*
- *The date and time of all monitoring results (monitoring in Parts 2.2.3.5.1.1.2, 2.2.3.5.1.1.4, and 2.2.3.5.1.1.5, as applicable);*
- *The analytical techniques or methods used as applicable, and*
- *The results of such analyses.*

You must submit your monitoring data as part of your annual report. For systems already in use as of the effective date of this permit, initial sampling data must be submitted with the first annual report. For systems which are not already in use as of the effective date of this permit, initial sampling data must be submitted on the annual report following the calendar year of the system's first use. Data must be submitted on the Ballast Water Treatment System Report form attached to the annual report available in Appendix H of this permit or electronically submitted to EPA: the system is scheduled to be available at www.epa.gov/npdes/vessels/eNOI.

[2.2.3.5.1.2 Onshore Treatment of Ballast Water]

[2.2.3.5.1.3 Use of Public Water Supply Water]

[2.2.3.5.1.4 No Discharge of Ballast Water]

[2.2.3.5.2 Schedule for when Ballast Water Treatment Becomes BAT (and Therefore Required)]

[2.2.3.5.3 Vessels Not Required to Meet Part 2.2.3.5 Treatment Standards]

2.2.3.5.3.3 Vessels That Operate Exclusively on the Laurentian Great Lakes (Commonly Known as Lakers) Built Before January 1, 2009

Existing Lakers built before January 1, 2009 confined exclusively to the Laurentian Great Lakes (i.e., existing vessels that operates upstream of the waters of the St. Lawrence River west of a rhumb line drawn from Cap de Rosiers to West Point, Anticosti Island, and west of a line along 63 W. longitude from Anticosti Island to the north shore of the St. Lawrence River) are not required to meet the requirements of Part 2.2.3.5.

Lakers built on or after January 1, 2009 must meet the treatment limits found in Part 2.2.3.5 of the permit.

[2.2.3.6 Interim requirements for vessels not meeting the ballast water management measures in Part 2.2.3.5]

2.2.3.7 Vessels Entering the Great Lakes

In addition to complying with the requirements of this permit, all vessels that are equipped to carry ballast water and enter the Great Lakes must comply with 33 CFR Part 151, Subpart C. Vessels that operate outside the EEZ and more than 200 nm from any shore and then enter the Great Lakes via the Saint Lawrence Seaway System must also comply with 33 CFR Part 401.30. Vessels that are unable, due to weather, equipment failure, or other extraordinary condition, to effect a BWE before entering the EEZ prior to entering the Great Lakes, must employ another method of ballast water management listed in 33 CFR 151.1510 or otherwise comply with the provisions of 33 CFR 151.1515.

Additionally, vessels utilizing a ballast water treatment system (see Part 2.2.3.5.1.1 of the permit) must also conduct ballast water exchange or saltwater flushing (as applicable) in addition to treating their ballast water if they meet the following requirements:

- *The vessel operates outside the EEZ and more than 200 nm from any shore and then enters the Great Lakes via the Saint Lawrence Seaway System, and*

- *The vessel has taken on ballast water that has a salinity of less than 18 parts per thousand from a coastal, estuarine, or freshwater ecosystem within the previous month (30 days)*.

If a vessel affected by these requirements has not taken on ballast water with a salinity of less than 18 parts per thousand in the previous month, the master of the vessel must certify to this effect in their ballast water recordkeeping requirements before entering the Great Lakes.

Among the options available to owners of ballast tank-equipped vessels in the 2013 VGP, the provisions related to on-board treatment of ballast water are substantively different from requirements that were contained in the 2008 VGP. This analysis therefore focuses most specifically on these provisions. As outlined in the 2013 VGP, onboard treatment requirements consist of three main components. First the VGP sets performance criteria for BWTS in terms of allowable limits on living organisms that may be discharged with ballast water. Second, the VGP contains limits on the amount of residual biocides or their derivatives that may be discharged into waters subject to the permit. Third, the VGP outlines required monitoring, sampling, testing, and reporting activities aimed at ensuring that the BWTS performs as specified and that the ballast water discharged meets the standards. The VGP also specifies additional requirements for vessels that treat their ballast water and enter the Great Lakes.

The BWTS performance criteria contained in the 2013 VGP follow the IMO and USCG standards. According to the schedule included by USCG in its final rule (77 FR 17254), all newly built vessels constructed on or after December 1, 2013 will have to comply with the discharge standards summarized in *Table 4-7* upon their delivery, while vessels constructed before December 1, 2013 will have to comply with the discharge standards as early as their first drydocking after January 1, 2014 or January 1, 2016, depending on their ballast water capacity.[34]

Note that some jurisdictions have different standards. For example, the State of California promulgated performance standards for ballast water discharges in that State's water that are structured differently than the IMO D-2 or USCG Phase One standard as they are based on a "no detectable living organism" standard for the larger size class. The other size classes contained in the California standards are similar (but not identical) to the "Phase Two" proposed by USCG in 2009 (74 FR 446321), but set a final implementation date of January 1, 2020 by which date vessels must have zero detectable living organisms in their ballast water discharge. California also provides explicit guidelines for sampling points and methods. The States of Michigan, Minnesota, and Wisconsin also have state-specific ballast water discharge standards. Other states, such as New York, Illinois, Indiana and Ohio have previously required ballast water treatment as part of their VGP 401 certification requirements.

[34] Existing vessels with ballast water capacity between 1,500 and 5,000 m^3 must comply starting January 1, 2014 while existing vessels with ballast water capacity less than 1500 m^3 or greater than 5,000 m^3 must comply starting January 1, 2016.

Given these existing USCG, IMO, and State requirements which are generally equivalent to, or even more stringent than the 2013 VGP, EPA does not expect the performance standards stipulated in the 2013 VGP to impose an incremental cost to vessel owners for the vast majority of vessels (i.e., except for vessels discussed in the *Cost Estimates* section). Vessels will already be required to comply with IMO, USCG, and state standards.

Table 4-7. USCG Phase One and IMO D-2 Ballast Water Discharge Standards.

Organism Size Class	Discharge Standard
>50 μm	<10/m^3
> 10 μm and ≤ 50 μm	<10/ml
≤ 10 μm	N/A
E. coli	<250 cfu/100 ml
Intestinal enterococci	<100 cfu/100 ml
Toxicogenic Vibrio cholerae (human cholera)	<1 cfu/100 ml

cfu = colony forming unit

In addition to these discharge standards, the 2013 VGP also stipulates monitoring, sampling, testing, and reporting activities that vessel owners must complete.

The purpose of these activities is two-fold: First, to monitor the operation of the BWTS to ensure that it functions as expected and as designed by the manufacturer, and second, to characterize the discharge at the discharge point into waters subject to the permit. Specific requirements include:

- ***Functionality monitoring***: Physical/chemical indicators of treatment performance verify that the ballast water treatment system is operating according to the manufacturers' requirements. Most ballast water treatment systems have control and self-diagnostic equipment that continuously measure treatment parameters to verify performance. Sensors commonly incorporated into the most frequently installed systems include flow meters, pH sensors, dissolved oxygen sensors, OPR and amperometric (TRO) sensors, and on-line chlorine analyzers. Other ballast water treatment systems are provided with testing meters or kits, such as portable chlorine and dissolved ozone monitors, to verify adequate levels of treatment chemicals are being maintained within the ballast tanks. Vessel operators monitor and record this data and make adjustments, maintenance, or repairs to the ballast water treatment system to ensure the equipment is functioning properly.
- ***Monitoring equipment calibration***: This requirement is meant to ensure that all applicable sensors and other control equipment are calibrated, when warranted, based on device drift and as recommended by sensor and equipment manufacturers, or by ballast water treatment system manufacturers.
- ***Effluent biological organism monitoring***: This requirement is intended to verify that the treatment system is operating properly by collecting a small volume sample and analyzing the sample for concentrations of certain indicator parameters.
- ***Residual biocide and derivative monitoring***: While ballast water treatment technologies reduce the probability of invasion, such treatment may introduce other water quality

impacts, such as toxicity. For example, the addition or in-process generation of disinfecting chemicals may result in an effluent with some residual toxicity. Therefore, for vessels having ballast water treatment systems that either add or generate biocides for treatment (e.g., chlorine, chlorine dioxide, ozone, etc.) the VGP 2013 requires that owners conduct monitoring of the vessel ballast water discharge for any residual biocides to demonstrate compliance with specified action levels.

AFFECTED VESSEL POPULATION

The total population of vessels potentially affected by practices applicable to the ballast water discharge category was described in *Section 2.5* of this report. *Table 4-7* summarizes estimates of the total number of domestic vessels potentially subject to ballast water standards, based on figures from the USCG (USCG, 2012a). Not all vessels, however, will use onboard treatment to comply with discharge requirements. Separate estimates developed by King et al. (2010) suggest that approximately 1,200 vessels with ballast water discharge are likely to install onboard BWTS. Other vessels are more likely to use an alternative compliance method such as not discharging ballast water while in regulated waters, using onshore facilities, or using freshwater as ballast.

Further, only a subset of the BWTS installed use biocides as disinfection methods and would have the potential to discharge residual biocides and therefore be subject to the related 2013 VGP requirements. According to Lloyd's Register (2011), about half of the 200 BWTS installed as of June 2011 use chemical disinfection methods that have the potential to discharge residual biocides.[35]

[35] These methods include ozonation, chlorination, electrolysis/electrochlorination, or most other chemical/biological treatment.

Table 4-8. Vessel Counts for Practices Applicable to Ballast Water Treatment.

Vessel Class	Vessels with Ballast Water Tanks[a]	Vessels Assumed to use Onboard BWTS[b]	BWTS with Potential to Discharge Residual Biocides[c]
Commercial Fishing	93	93	46
Freight Barges	-	-	-
Freight Ships	450	404	202
Passenger Vessels	154	154	77
Tank Barges	-	-	-
Tank Ships	72	72	36
Utility Vessels	895	121	61
TOTAL	**1,665**	**844**	**422**

a Based on USCG estimates, adjusted for vessel growth rates.

b Based on estimates by King et al. (2010).

c Half of the BWTS installed (capped to the number of vessels with ballast water tanks) are assumed to use chemical disinfection methods.

Vessels that use a BWTS and enter the Great Lakes are subject to additional flushing requirements if: (1) they operate outside the EEZ and more than 200 nm from any shore and then enter the Great Lakes via the Saint Lawrence Seaway System, and (2) they have taken on ballast water that has a salinity of less than 18 ppt from a coastal, estuarine, or freshwater ecosystem within the previous month.

EPA could not find data on the exact number of vessels that meet the two criteria above. Data on ballast water discharges in the Great Lakes and Saint-Lawrence Seaway System (GLSLSS) by transoceanic ships in 2002 suggests that there were 46 vessel visits that year from ships with ballast on board, each discharging 10,000 m^3, and an additional 531 visits from unballasted vessels (Cangelosi and Mays, 2006), for a total of 566,200 m^3 discharged. NBIC data for 2009 show 188 vessels discharging a total of 1,050,920 m^3 of ballast water in states bordering the Great Lakes. This is equivalent to about a quarter of non-commercial fishing vessels assumed to use onboard BWTS. For the purpose of this analysis, EPA distributed the vessels assumed to enter the Great Lakes according to the previously estimated number of vessels assumed to use onboard BWTS, as shown in *Table 4-9*.

Table 4-9. Vessel Counts for Practices Applicable to Ballast Water Treatment for Vessels Entering the Great Lakes.

Vessel Class	Vessels with Ballast Water Tanks[a]	Vessels Assumed to use Onboard BWTS[b]	Vessels Assumed to Enter the Great Lakes[c]
Commercial Fishing	93	93	-
Freight Barges	-	-	-
Freight Ships	450	404	101
Passenger Vessels	154	154	38
Tank Barges	-	-	-
Tank Ships	72	72	18
Utility Vessels	895	121	30
TOTAL	**1,665**	**844**	**188**

a Based on USCG estimates, adjusted for vessel growth rates.

b Based on estimates by King et al. (2010).

c 25% of the BWTS installed are assumed to be on vessels that enter the Great Lakes.

Finally, certain oil tankers exclusively engaged in coastwise trade are not covered under the USCG requirements but may need to install and operate a BWTS under the 2013 VGP. EPA could not find detailed information on the universe of tankers engaged in coastwise trade exclusively. However, a review of NBIC data for 2009 and 2010 suggests that 41 percent of tankers that reported ballast water discharges during the two years had only ballast water categorized as "coastwise." EPA used this information to estimate the number of tank ships with ballast water tanks that may be engaged exclusively in coastwise trade, i.e., 42 percent of 72 vessels, or 30 tank ships.

Table 4-10. Vessel Counts for Incremental BWTS Installation and Operation.

Vessel Class	Vessels with Ballast Water Tanks	Incremental Vessels Assumed to Install and Operate Onboard BWTS[a]
Commercial Fishing	93	-
Freight Barges	-	-
Freight Ships	450	-
Passenger Vessels	154	-
Tank Barges	-	-
Tank Ships	72	30
Utility Vessels	895	-
TOTAL	**1,665**	**30**

a Represents vessels not subject to already covered by USCG BWTS requirements. Number estimated based on approximate fraction of tank ships reporting ballast water discharges from coastwise sources only.

COST ESTIMATES

There are three main categories of costs for complying with the ballast water treatment requirements: 1) costs associated with the purchase, installation, and operation of the treatment system; 2) costs associated with BWTS functionality monitoring and equipment calibration; and 3) costs associated with discharge monitoring.

These costs are discussed below.

Capital and O&M Costs

Since the 2013 VGP performance standards are the same as those expected to be in effect under the USCG regulations (USCG, 2012a), vessels are assumed to already have to comply with these requirements in the baseline and the cost of installing BWTS is not an incremental cost attributable to the 2013 VGP. For a detailed assessment of those costs, see the USCG *Regulatory Analysis and Final Regulatory Flexibility Analysis* (USCG, 2012a), which is available in the docket for the VGP. EPA concurs with both the cost assessment developed by the USCG and their conclusion that based on the analysis of this available information, technology should be available for installation onboard vessels to meet the *Alternative 2* (BWD-2) standard, the IMO regulation D-2, by the 2013 initial implementation date.

As discussed above, certain oil tankers with ballast water tanks and engaged exclusively in coastwise trade may have to install on-board BWTS to meet the 2013 VGP requirements. EPA accounts for these costs in its analysis of the 2013 VGP. EPA used cost estimates developed by USCG to estimate the cost of installing and operating a BWTS for these vessels. According to the USCG analysis, the average per vessel capital costs are estimated at $420,408 (including installation), and annual operating costs are $8,488.[36] In addition, the permit requires that "Lakers" (see Appendix A of the permit for the definition of "Lakers") built on or after January 1, 2009 meet the discharge standards for ballast water. EPA notes that the USCG final regulation, (USCG, 2012a), does not include this specific requirement and was therefore not included in the regulatory cost analysis conducted for that rule. While this requirement could impose additional cost for new Lakers needing to install ballast water treatment systems as a means to comply with the discharge standards, EPA does not expect any new U.S. flagged Lakers to be built during this permit term. Thus, EPA has not included the quantified costs of this requirement in the total cost of the 2013 VGP. At this time, EPA is unaware of any U.S. flagged Lakers having been built since 2009, or that are scheduled to be built before the end of this permit term. However, in the event that a new U.S. Laker will be built, EPA expects the cost of installing treatment to be comparable to that of the vessels used in the USCG regulatory cost analysis. Based on this analysis, the USCG concludes that, "Over the 10-year period of analysis, the total cost of the FR BWDS for the U.S. vessels is approximately $648.86 million using the 7 percent discount rate and $768.20 million using the 3 percent discount rate. Our cost assessment includes existing and new vessels." (USCG, 2012a, pp 15-16). Therefore, the total cost per vessel over 10 years would

[36] The per vessel costs are calculated by dividing the total costs for Handy tank ships from tables 4.3 and 4.5 of USCG (2012a) by the number of Handy tank ships in table 4.2. EPA brought the 2007 costs to 2010 dollars by multiplying the values by the GDP deflator (1.041).

range between $444,730 and $526,525 assuming a universe of 1,459 vessels needing to install treatment. This is approximately $44,730 to $52,653 per vessel per year.

In order to explore how much ballast water treatment systems would cost if a U.S. flagged Laker were to install a treatment system, EPA used the same methodology as that contained within the Coast Guard rulemaking to provide consistency. In the event that 1 to 3 U.S. flagged Lakers are built during the permit term, the annualized cost attributable to this permit would range from $52,653 for one vessel to $157,959 per year for three vessels. This estimate was calculated using the upper bound annual cost estimate of $52,653 per vessel, as well as a conservative estimate that compliance would be required for all five years of the permit term. Based on this information, EPA concludes that, while unlikely, in the event that a new U.S. Laker is required to install a treatment system in order to comply with the discharge standards during the duration of this permit term, the treatment technology is available and their use is economically achievable for new Lakers.

EPA is aware that there may be foreign flagged Lakers built after this date that would be subject to this requirement; however, for purposes of calculating costs of the permit requirements, foreign flagged vessels are excluded from the analysis of the total costs of implementing this discharge standard.

Functionality Monitoring and Calibration

The second potential cost component relates to monitoring the BWTS to ensure that it is functioning properly, and as necessary, calibrating sensors and probes. For example, this practice may involve monitoring filters, chemical injection, and dosage equipment, tracking energy usage of the UV system, and inspecting any other necessary components of the system to ensure that they are working as designed and specified by the manufacturer. Since all ballast water treatment systems are expected to come equipped with the necessary sensors and monitoring equipment, capital costs are expected to be minimal. In the unlikely event that sensors and monitoring equipment need to be installed, their costs would need to be accounted for when estimating VGP compliance costs. For example, upfront capital costs for installing additional monitoring equipment for a filtration and chlorine dioxide system are approximately $10,000, or about $920 per year (annualized using a discount rate of 7 percent and life of 20 years).[37]

EPA estimates that each inspection or monitoring event may require about 1.15 hour to complete (1 hour to conduct an inspection and 9 minutes to record findings) and that these events are conducted monthly. EPA further assumes that re-calibration may be needed annually, with each calibration event requiring 8 hours of staff time and 15 minutes in recordkeeping time. The total annual burden of these two activities amounts to about 22 hours per year. Since compliance with the IMO, USCG or other applicable discharge standards already implies that the vessel owner

[37] This is based on the purchase of a turbidity meter ($2,350) and chlorine dioxide sensor ($984) and installed costs equal to three times the equipment cost. The total installed capital cost is estimated at $9,732 (3 x $2,350 + 3 x 984).

monitors the BWTS and recalibrates sensors and probes as needed, costs specifically attributed to the 2013 VGP are limited to any additional recordkeeping that is specific to the VGP.[38] For the purpose of this analysis, EPA estimated the additional VGP-specific recordkeeping burden at 2 hours per year (9 minutes each month for ongoing inspections, plus 15 minutes for documenting annual calibration). Based on an average labor rate of $33.72 per hour, costs for this requirement average about $69 per vessel per year.

Discharge Monitoring for Biological Indicators and Residual Biocides

The third potential cost component relates to the testing of ballast water effluent from the BWTS for the presence of bacterial indicators and residual biocides, if applicable. While some vessel owners may already test their effluent to ensure the proper performance of the BWTS, this testing is not generally required to comply with the IMO or USCG discharge standards and EPA therefore assumes that all vessels equipped with a BWTS would need to conduct additional sampling and testing to comply with the 2013 VGP.[39]

The 2013 VGP stipulates two types of discharge monitoring: biological indicators and residual biocides (if applicable for the type of BWTS). In both instances, the VGP specifies the parameters to be analyzed and the frequency of monitoring, depending on the type of treatment system installed.

The required biological indicator compliance testing of ballast water effluent must be conducted 2 times during the first year the system is installed or used for vessels with devices for which high quality or type approved data, are available. For these vessels, if sampling results are below permit limits for two consecutive events, the vessel owner/operator may reduce monitoring to one time per year after the first year. However, if the vessel owner/operator exceeds a permit limit on any sampling event, they must return to monitoring two times per year until they have two additional results below permit limits. For vessels for which high quality or type approved data, data are not available, monitoring must be conducted 4 times per year.

The 2013 VGP requires discharge testing for the presence of residual biocides, if applicable, several times during the initial 90 days of permit coverage, followed by maintenance monitoring thereafter. The number of sampling events needed during the first 90 days (3 to 5 events) and the frequency of subsequent monitoring events (2 or 4 events per year) is dependent on the availability of high quality or type approved data, as summarized in *Table 4-11* below.

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[38] California regulations (Public Resources Code Section 71205(g)) require that the vessel owner maintain a ballast water treatment performance log on board the vessel. At a minimum, this treatment performance log must include: The dates, times, and locations of the starting and stopping of the system for the purpose of treating ballast water; Dates, time and descriptions of any system malfunctions, including problem resolution; Dates, times and locations of both scheduled and unscheduled maintenance of the system; All relevant measures of system performance recorded during system operation (for example - UV transmittance, residual chemical concentration).

[39] The State of California encourages owners to conduct regular performance testing to ensure that the treatment system is working properly, but system performance verification is not specifically required under Public Resources Code Section 71205(g).

Table 4-11. Discharge Sampling and Testing Requirements.

Type of Monitoring	Type approved devices for which all "high quality" data are available	Type approved devices for which "high quality" data are not available
Biological Indicators	2 times per year	4 times per year
Residual Biocides		
Initial Monitoring[a]	3 times during first 90 days	5 times during first 90 days
Maintenance Monitoring	2 times per year	4 times per year

a The initial monitoring is conducted only once during the period of the Permit.

Each sampling event involves collecting ballast water effluent samples and either analyzing these samples on-board the vessel or sending the samples to an onshore laboratory for analysis. The cost of each event consists of labor hours for vessel staff and laboratory costs (including sample shipping and handling).[40]

EPA estimated that each sampling event will require 2 hours to complete and 0.5 hour to record. Additional sampling for biocide, in the case of vessels equipped with systems that have the potential to discharge residual biocide, is estimated to require 1 hour to complete, and 0.5 hour to record. *Table 4-12* presents assumed incremental burden and cost estimates for discharge sampling and analytical testing of ballast water discharges.

[40] While vessel owners may decide to do some analyses onboard the vessel, the use of outside laboratories is used as an upper bound on compliance costs.

Table 4-12. Annual per vessel cost of ballast water monitoring requirements.

Practice	Incremental Burden (hours)	Lab and Incidental Costs	Frequency (#/year)	Annual Cost[a e]
BWTS monitoring[b]	0.15	None	12	$60.70
BWTS calibration[c]	0.25	None	1	$8.43
If Using Type approved devices for which all "high quality" data are available				
Biological sampling and testing [d]	2.50	$150	2	$468.61
Initial biocide sampling and testing [e]	1.50	$150	3	$97.84
Maintenance biocide sampling and testing[f]	1.50	$150	2	$401.17
If Using Type approved devices for which "high quality" data are not available				
Biological sampling and testing [d]	2.50	$150	4	$937.22
Initial biocide sampling and testing [e]	1.50	$150	5	$195.68
Maintenance biocide sampling and testing [f]	1.50	$150	4	$802.33

a Annual cost calculated as burden hours times the average labor rate of $33.72/hour plus lab and incidental costs times the frequency.

b Burden associated with the additional recordkeeping that may be needed under the VGP.

c Burden associated with the additional recordkeeping that may be needed under the VGP.

d Testing for E. coli, enterococci, and total live bacteria.

e Annual cost of the initial biocide sampling and testing represents one-time costs of initial testing annualized over 5 years (at 7% discount rate) of the VGP and assumes that the initial round of biocide sampling and testing replaces one periodic monitoring event.

f Based on testing for trihalomethanes or bromoform.

Note that EPA generally assumed that vessels will test for the presence of residual biocides and their corresponding derivatives and analytes listed in Table 5 of the 2013 VGP, namely: alkylamines, chlorine or chlorine dioxide, methadione, ozone, peracetic acid. In instances where the biocide used or produced by the BWTS and its derivatives is not one listed in the 2013 VGP, the vessel owner will have to conduct whole effluent toxicity (WET) testing. The requirements for such testing are similar to requirements that were contained in the 2008 VGP, and relatively few vessels are expected to conduct WET testing. Therefore, EPA assumed that this provision does not represent an incremental cost.

Additional Operating Costs for Vessels Entering the Great Lakes

Certain vessels that use an onboard BWTS and enter the Great Lakes must conduct ballast water exchange or saltwater flushing (as applicable) in addition to treating their ballast water. This requirement has the potential to increase operating costs for these vessels by increasing the volume of water exchanged and treated. To estimate the incremental costs, EPA relied on estimates of the operating cost for ballast water treatment and exchange developed by the U.S. Coast Guard (USCG, 2012a), summarized in *Table 4-13*.

Table 4-13. Ballast Water Treatment and Exchange Costs.

Practice	Unit Cost ($\$/m^3$)[c]
Treatment[a]	$0.259
Exchange[b]	$0.035

a Based on costs in Table 3.6 of USCG (2008). Represents the average cost across different treatment systems (chlorine generate, chemical apply, filter and radiate, deoxygenate, and ozone generate) for Handy bulk carriers, escalated to 2010 dollars using CCI.

b Based on costs in Table B-3 of USCG (2008). Represents the average cost of systems capable of treating 750 m^3/hour and 2,000 m^3/hour, escalated to 2010 dollars using CCI.

c Cost originally stated in 2007 dollars were escalated to 2010 dollars using CCI (adjustment factor = 1.1049).

Reporting

Vessel owners must submit data on their compliance with ballast water treatment standards as part of their annual reporting to EPA. The incremental burden of compiling the information collected during each inspection or sampling event for use in the existing annual report is assumed to be negligible relative to the estimated burden of each event and of the annual report.

SENSITIVITY ANALYSIS

EPA estimated the potential incremental costs to vessel owners using the cost input values presented above and the following assumptions.

Ballast Water Treatment Costs

- *Vessel population:* Given existing requirements assumed in the baseline, EPA assumed that only oil tanker engaged in coastwise trade exclusive may incur costs for installing and operating a BWTS specifically to comply with the 2013 VGP. EPA assumed that between 0 and 30 vessels would incur these costs during the 5-years of the permit.
- *Baseline and Incremental Costs:* EPA used cost estimates developed by USCG to estimate the cost of installing and operating BWTS for these vessels. These costs include capital costs of $420,408 per vessel (including installation) and O&M costs of $8,488. Annualized capital costs are $55,941 per vessel (assuming 10-year at 7 percent).

Table 4-14. Annual per vessel cost of ballast water treatment system for oil tankers engaged in coastwise trade exclusively.

Vessel Class	Vessels Installing BWTS due to the VGP[a]	Annualized Capital Cost[b]	Annual O&M Cost[b]	Total Annual Cost
		Low End Estimate		
Tank Ships	0	$55,941	$8,488	$64,429
		High End Estimate		
Tank Ships	30	$55,941	$8,488	$64,429

a Represents vessels with ballast water tanks not already covered by USCG BWTS requirements. Number estimated based on approximate fraction of tank ships reporting ballast water discharges from coastwise sources only.

b Estimated based on USCG (2012a); Costs brought to 2010 dollars; Capital costs annualized over 10 years using 7 percent discount rate.

Performance Monitoring Costs

- *Vessel population:* EPA estimated the population of vessels potentially subject to the discharge standard based on figures presented in USCG (2012). Only a fraction of these vessels, however, may ultimately install a BTWS to comply with the discharge requirements. Based on estimates presented in King et al. (2010), EPA assumed that about 40 percent of vessels will install a BTWS in the low end estimate, and 60 percent in the high end estimate. This subset of vessel is assumed to conduct performance monitoring.

- *Baseline and Incremental Costs:* BWTS already include the necessary instruments to monitor performance. Further, vessel owners are assumed to already comply with manufacturers' recommendation concerning the monitoring and calibration of monitors and probes as part of their existing operations. Incremental costs are assumed to consist of recordkeeping requirements specific to the 2013 VGP and are the same in the low and high end estimates (see *Table 4-12*).

Effluent Sampling and Testing Costs

- *Vessel population*: The types of tests needing to be performed for each vessel depends on the type of system used to disinfect the effluent. All vessels that use a BWTS will have to conduct sampling and testing for biological parameters (E. coli, enterococci, etc.). Only some systems have the potential to discharge residual biocide, however, and would have to test for the presence of biocides in the effluent. Systems that have the potential to discharge residual biocides are those that disinfect using chemical inactivation (using chlorine or other biocide such as menadione). Systems that use physical disinfection (UV, deoxygenation, cavitation, heat) do not have the potential to discharge residual biocides and vessels equipped with these systems would not incur the related testing cost. Based on information available from Lloyd's Register, about half of the BWTS installed on vessels will use some form of chemical disinfection with the potential to discharge residual biocide. EPA therefore assumes that 100 percent of vessels using a BWTS will conduct sampling and testing for biological indicators, whereas between 50 percent (low end) and 75 percent (high end) of the vessels with BWTS incur incremental costs for biocide sampling and testing.

- *Sampling frequency:* The frequency of biocide testing depends on the type of BTWS installed, and in particular, whether the device is type-approved in the U.S. (or data have been made available to EPA). In general, EPA assumes that BTWS manufacturers will willingly share their data to gain approval in the U.S. as they have market incentives to do so. Nevertheless, EPA conservatively assumed that some vessels may use BTWS that have not been type approved in the U.S. For the low end estimate, EPA assumes that 1percent of vessels use BWTS that are not type-approved in the U.S. and would be subject to the more frequent testing requirements. This fraction is assumed to be 5 percent in the high end estimate.
- *Baseline:* None of the vessels subject to the sampling and testing requirement are assumed to conduct sampling and testing in the baseline. Therefore, the costs of conducting biological sampling and testing (and biocide sampling and testing, if applicable) are assumed to be incremental costs attributable to the 2013 VGP.
- *Unit Costs:* Assumed unit costs are the same in the low end and high end estimates (see *Table 4-12*). Costs per vessel depend on the type of BWTS used. As described above, EPA assumes that 1 percent and 5 percent of vessels may use type approved devices for which data are not available in the low and high end estimates, respectively. The costs per vessel are then calculated as the weighted average annual frequency of monitoring events multiplied by the cost of each monitoring event. For example, for biological monitoring, this cost is $473.30 per vessel per year for the low end estimate (0.99 x 2 + (1-0.99) x 4) x $234.31)

Vessels Entering the Great Lakes

- *Vessel population:* EPA estimated the population of vessels potentially subject to the Great Lakes-specific requirements based on NBIC data on the number of unique vessels (188 vessels) that discharged ballast water in states adjoining the Great Lakes in 2009 (NBIC, 2011).[41] Only a fraction of these discharges, however, are applicable discharges, i.e., took place within the Great Lakes, would meet the VGP applicability criteria (i.e., vessel operates outside the EEZ and more than 200 nm from shore and has taken on ballast with a salinity of less than 18 ppt), and involved vessels that use an onboard BWTS. The data is not sufficiently detailed to estimate the exact number of vessels and associated discharges subject to the Great Lakes-specific VGP requirement. For the purpose of this analysis, EPA assumed that half the discharged volume reported in states adjoining the Great Lakes would be subject to the Great Lakes-specific exchange requirements.

[41] Another 751 vessels reported no discharge.

- *Volume Exchanged and Treated:* Based on NBIC data for 2009, vessels discharged a total of 1,050,779 m^3 of ballast water that year, or an average of 5,590 m^3 per discharging vessel per year. Some vessels use a flow-through exchange method involving the pumping of three times the ballast tank capacity while other vessels simply empty and refill their tank. The volume exchanged affects operational costs by increasing pumping and treatment costs. In the absence of information on the volume of water exchanged using each of these two methods, EPA assumed that 0 to 50 percent of vessels conduct flow through exchange for the low and high end estimates, respectively. This assumption is combined with the assumption regarding the fraction of vessel visits involving applicable discharges discussed in the previous paragraph (50 percent) to estimate the volume exchanged and treated. Thus, for the low end estimate, EPA assumed that 525,460 m^3 of ballast water of water must be exchanged and treated ($0.5 \times 1{,}050{,}920\ m^3$). For the high end estimate, EPA assumed that 262,730 m^3 are exchanged using the empty-refill method (half of the volume calculated above), and 788,190 m^3 are exchanged using the flow-through method (three times the remaining volume).
- *Baseline:* EPA assumed that all exchanges and treatment costs are attributable to this requirement.

The estimated cost per vessel for each practice and the total cost associated with all vessels are summarized in *Table 4-15*.

Table 4-15. Ballast Water Treatment Sensitivity Analysis.

Vessel Class	Number of Vessels	Annual Cost per Vessel	Total Annual Cost
Low End Estimate			
Treatment Costs			
Commercial Fishing	-	-	$-
Freight Barges	-	-	$-
Freight Ships	-	-	$-
Passenger Vessels	-	-	$-
Tank Barges	-	-	$-
Tank Ships	-	$64,429	$-
Utility Vessels	-	-	$-
Treatment Costs TOTAL	-		**$-**
BWTS Monitoring			
Commercial Fishing	37	$69.13	$2,570
Freight Barges	-	-	$-
Freight Ships	180	$69.13	$12,445
Passenger Vessels	62	$69.13	$4,258
Tank Barges	-	-	$-
Tank Ships	29	$69.13	$2,001
Utility Vessels	358	$69.13	$24,756
Monitoring TOTAL	**666**		**$46,030**
Sampling and Testing (biological)			
Commercial Fishing	37	$449.20	$16,699
Freight Barges	-	-	$-
Freight Ships	180	$449.20	$80,866

Vessel Class	Number of Vessels	Annual Cost per Vessel	Total Annual Cost
Passenger Vessels	62	$449.20	$27,668
Tank Barges	-	-	$-
Tank Ships	29	$449.20	$12,999
Utility Vessels	358	$449.20	$160,862
Biological Sampling TOTAL	**666**		**$299,096**
Sampling and Testing (biocides)			
Commercial Fishing	19	$504.00	$9,368
Freight Barges	-	-	$-
Freight Ships	90	$504.00	$45,366
Passenger Vessels	31	$504.00	$15,522
Tank Barges	-	-	$-
Tank Ships	14	$504.00	$7,293
Utility Vessels	179	$504.00	405.18
Biocides Sampling TOTAL	**333**		**$167,792**
Great Lakes-Specific Requirements			
Commercial Fishing	-	-	$-
Freight Barges	-	-	$-
Freight Ships	101	$820.68	$82,888
Passenger Vessels	38	$820.68	$31,593
Tank Barges	-	-	$-
Tank Ships	18	$820.68	$14,843
Utility Vessels	30	$820.68	$24,825
Biocides Sampling TOTAL	**188**		**$154,151**
Low End Total			**$667,068**
High End Estimate			
Treatment Costs			
Commercial Fishing	-	-	$-
Freight Barges	-	-	$-
Freight Ships	-	-	$-
Passenger Vessels	-	-	$-
Tank Barges	-	-	$-
Tank Ships	30	$64,429	$1,911,104
Utility Vessels	-	-	$-
Treatment Costs TOTAL	30		**$1,911,104**
BWTS Monitoring			
Commercial Fishing	56	$69.13	$3,855
Freight Barges	-	-	$-
Freight Ships	270	$69.13	$18,668
Passenger Vessels	92	$69.13	$6,387
Tank Barges	-	-	$-
Tank Ships	43	$69.13	$3,001
Utility Vessels	537	$69.13	$37,135
Monitoring TOTAL	999		**$69,045**
Sampling and Testing (biological) [a]			
Commercial Fishing	56	$468.92	$26,148
Freight Barges	-	-	$-
Freight Ships	270	$468.92	$126,624

Vessel Class	Number of Vessels	Annual Cost per Vessel	Total Annual Cost
Passenger Vessels	92	$468.92	$43,324
Tank Barges	-	-	$-
Tank Ships	43	$468.92	$20,355
Utility Vessels	537	$468.92	$251,886
Biological Sampling TOTAL	999		**$468,338**
Sampling and Testing (biocides) [a]			
Commercial Fishing	42	$953.99	$39,898
Freight Barges	-	-	$-
Freight Ships	203	$953.99	$193,208
Passenger Vessels	69	$953.99	$66,106
Tank Barges	-	-	$-
Tank Ships	33	$953.99	$31,058
Utility Vessels	403	$953.99	$384,336
Biocides Sampling TOTAL	**749**		**$714,606**
Great Lakes-Specific Requirements			
Commercial Fishing	-	-	$-
Freight Barges	-	-	$-
Freight Ships	101	$1,641.35	$165,777
Passenger Vessels	38	$1,641.35	$63,187
Tank Barges	-	-	$-
Tank Ships	18	$1,641.35	$29,687
Utility Vessels	30	$1,641.35	$49,651
Biocides Sampling TOTAL	**188**		**$308,301**
High End Total			**$3,471,394**

Total may not add up due to rounding.

REVISED DATE FOR NEW BUILD VESSELS

EPA has reviewed the characteristics of vessels that may need to install ballast water treatment systems in establishing VGP requirements for this discharge category. As determined by the USCG in their analysis of the March 2012 rulemaking, an estimated 1,459 domestic flagged vessels are expected to install BWTS through 2018 at costs that range from $258,000 for chemical application in offshore supply vessels to more than $2.5 million to retrofit Very Large Crude Carriers (VLCCs) with ozone generating systems. USCG estimated the total annual cost for the rule at $90 million (at 3 percent discount rate, in 2007 dollars). In estimating the total cost, USCG assumed that vessels would be in full compliance with the requirement by 2018. The ballast water treatment system equipment installation requirements are phased-in for existing vessels over the 2014 through 2016 period. Table ES-3, on page 14 of the USCG *Regulatory Analysis and Final Regulatory Flexibility Analysis*, presents the number of potential vessels operating in U.S. waters that are projected to install ballast water treatment systems (USCG, 2012a).

As proposed, the VGP would have required any new vessel constructed after January 1, 2012 to comply with the specified effluent limits. According to the schedule included by USCG in its final rule (77 FR 17254), however, all newly built vessels constructed on or after December 1, 2013 will have to comply with the discharge standards summarized in Table 4-7 upon their delivery, while vessels constructed before December 1, 2013 will have to comply with the discharge standards as early as their first drydocking after January 1, 2014 or January 1, 2016, depending on their ballast water capacity. The date originally proposed by EPA would have resulted in cases where owners of vessels constructed between January 1, 2012 and December 1, 2013 would be installing systems that might not be granted AMS or type approval by USCG; vessel owners, therefore, could need to subsequently modify or replace the systems to comply with the effluent limits within a two year time period, at potentially significant costs. Further, as determined by the USCG, there may not be an adequate number of BWTS that get AMS or USG type approval to allow vessel owners to meet a compliance date of January 1, 2012 (see Page 100 of Regulatory Analysis and Final Regulatory Flexibility Analysis: Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters, March 2012). Finally, vessel owners could need to determine whether the effectiveness of the available systems has been properly assessed, including testing through an independent third party laboratory, without the additional assurance being provided by the United States government's review of the systems, exposing the vessel owners to yet further risk of having to do a very short term replacement of their ballast water systems.

USCG estimated that BWTS installation may be delayed for up to 600 vessels constructed between January 1, 2012 and December 1, 2013. Although it may be economically achievable to install BWTS technology prior to AMS or type-approval, given the risks that given systems may not obtain AMS and US Coast Guard type-approval, costly modification or replacement could be required for many vessels. Hence, EPA does not consider BWTS technology to be economically achievable for this category of sources prior to US Coast Guard AMS or type-approval. Therefore, EPA has extended the implementation schedule slightly to be consistent with the USCG regulation and thereby ensure that vessel owners have the information necessary to make the best decision possible in choosing technology that will meet the numeric effluent limits. Note that vessel owner/operators not subject to the requirements of Part 2.2.3.5 of the permit must meet the exchange and flushing requirements in Part 2.2.3.6.

4.2.4 ANTI-FOULING HULL COATINGS

PERMIT REQUIREMENTS

The 2013 VGP clarifies the 2008 VGP requirements regarding the use of TBT, whether or not used as a biocide, as well as the use of other non-TBT organotin compounds used as catalysts.

AFFECTED VESSEL POPULATION

Since the Global Anti-fouling System Treaty came into effect on September 22, 2008 and the 2008 VGP prohibited the use of TBT on all vessels, few vessels are expected to still use TBT on their hulls.

***Permit Text**:*

2.2.4 Anti-Fouling Hull Coatings/ Hull Coating Leachate

- *All anti-fouling coatings subject to this permit must meet the requirements of the Clean Hull Act of 2010.*
- *All anti-fouling hull coatings subject to registration under FIFRA (see 40 CFR § 152.15) must be registered, sold or distributed, applied, maintained, and removed in a manner consistent with applicable requirements on the coatings' FIFRA label.*
- *For anti-fouling hull coatings not subject to FIFRA registration (i.e., not produced for sale and distribution in the United States), hull coatings must not contain any biocides or toxic materials banned for use in the United States (including those on EPA's List of Banned or Severely Restricted Pesticides). This requirement applies to all vessels subject to this permit, including those registered and painted outside the United States.*

At the time of initial application or scheduled reapplication of anti-fouling coatings, you must give consideration, as appropriate for vessel class and vessel operations, to the use of hull coatings with the lowest effective biocide release rates, rapidly biodegradable components (once separated from the hull surface), or non-biocidal alternatives, such as silicone coatings.

Some ports and harbors are impaired by copper, a biocide used commonly in anti-foulant paints. These waters include Shelter Island Yacht Basin in San Diego, California, and waters in and around the ports of Los Angeles/Long Beach. A complete list of such waters may be found at www.epa.gov/npdes/vessels. When vessels spend considerable time in these waters (defined as spending more than 30 days per year), or use these waters as their home port (i.e., house boats, ferries or rescue vessels), vessel owners/operators shall consider using anti-fouling coatings that rely on a rapidly biodegradable biocide or another alternative rather than copper-based coatings. If after consideration of alternative biocides, vessel operators continue to use copper-based antifoulant paints, they must document in their recordkeeping documentation how this decision was reached.

The discharge of Tributyltin (TBT) from any source (whether used as a biocide or not) or any other organotin compound used as a biocide is prohibited by this permit. Therefore, vessel owners/operators covered by this permit have a zero discharge standard for TBT (whether or not used as a biocide) or any other organotin compound used as a biocide. You may not use an antifoulant coating containing TBT or any other organotin compound used as a biocide. If the vessel has previously been covered with a hull coating containing TBT (whether or not used as a biocide) or any other organotin compound used as a biocide, vessels must be effectively overcoated so that no TBT or other organotin leaches from the vessel hull or the TBT or other organotin coating must have been removed from the vessel's hull.

When used as a catalyst, an organotin compound other than TBT (e.g., dibutyltin) is not to be present above 2500 mg total tin per kilogram of dry paint. Furthermore, the coating shall not be designed to slough or otherwise peel from the vessel hull. Incidental amounts of coating discharged by abrasion during cleaning or after contact with other hard surfaces (e.g., moorings) are not prohibited.

COST ESTIMATES

No requirements within this discharge category for TBT require cost analysis because these requirements already apply in the baseline. EPA assumes that the requirements for other anti-fouling paints have negligible cost implications. Finally, while vessel owners that decide, after consideration of alternative biocides, to continue to use copper based antifoulant paints will have to document the basis of their decision, these documentation requirements are anticipated to represent a minimal additional burden for these vessel owners relative to the annual paperwork burden discussed in *Section 4.4*.

4.2.5 AQUEOUS FILM-FORMING FOAM

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that potentially incur incremental costs for these requirements are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that commercial fishing vessels typically do not have firefighting systems that require regular AFFF discharge. This discharge category is assumed to have zero incremental cost.

4.2.6 BOILER/ECONOMIZER BLOWDOWN

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that potentially incur incremental costs for these requirements are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to boiler/economizer blowdown discharges have negligible costs and/or the industry is assumed to currently practice the Permit requirements. This discharge category is assumed to have zero incremental cost.

4.2.7 CATHODIC PROTECTION

PERMIT REQUIREMENTS

The 2013 VGP retains the requirements present in the 2008 VGP but adds specific practices to prevent the growth of fouling organisms at the sacrificial anode location, when feasible.

Permit Text:

Cathodic protection must be maintained to prevent the corrosion of the ship's hull. The discharge of zinc, magnesium, and aluminum are expected from properly functioning cathodic protection sacrificial electrodes. However, vessel operators must minimize the flaking of large, corroded portions of these anodes. Sacrificial anodes must not be used more than necessary to adequately prevent corrosion of the vessel's hull, sea chest, rudder, and other exposed areas of the vessel. Vessel operators must appropriately clean and/or replace these anodes during periods of maintenance (such as drydocking), so that release of these metals to waters is minimized. Furthermore, when feasible, sacrificial anodes should be flush-fitted to the hull, or vessel operators must fill the space between the anode and hull backing to remove the potential for hotspots for fouling organisms.

Vessel operators should note that magnesium is less toxic than aluminum and aluminum is less toxic than zinc. If vessel operators use sacrificial electrodes, they must select electrode devices with metals that are less toxic to the extent technologically feasible and economically practicable and achievable. For vessels that spend the majority of their time in freshwater, if aluminum or zinc is selected, the vessel owner/operator must document in their recordkeeping documentation why the use of magnesium is not appropriate. Likewise, for vessels that spend the majority of their time in saltwater, if vessel zinc is selected, the vessel owner/operator must document why aluminum is not selected. The documentation requirement is applicable after the vessel's first drydocking after December 19, 2013 (e.g., if the vessel drydocks in 2015, the requirement is applicable for that vessel starting in 2015).

EPA recommends, particularly for new vessels, the use of Impressed Current Cathodic Protection (ICCP) in place of or to reduce the use of sacrificial electrodes when technologically feasible (e.g., adequate power sources, appropriate for vessel hull size and design), safe, and adequate to protect against corrosion. If vessel operators use ICCP, they must maintain dielectric shields to prevent flaking.

AFFECTED VESSEL POPULATION

Based on the description of practices within this discharge category, all vessels with steel hulls within each of the vessel classes are potentially subject to the cathodic protection practices. Data from MISLE and WTLUS indicates that approximately 93 percent of vessels overall have steel hulls, although the fraction of steel hulled vessels varies by vessel type from 51 percent of passenger vessels to over 95 percent of freight barges and tank barges. Commercial fishing vessels, 79 percent of which are steel hulled, are newly covered by the VGP and therefore potentially incur incremental costs for this discharge category, while other types of vessels only potentially incur incremental costs from the additional requirements pertaining to fouling organisms. The population potentially affected by practices applicable to the cathodic protection discharge category is shown in *Table 4-16.*

Table 4-16. Vessel Counts for Cathodic Protection Practices.

Vessel Class	Vessel Count[a]
Commercial Fishing	1,967
Freight Barges	38,834
Freight Ships	730
Passenger Vessels	1,018
Tank Barges	6,941
Tank Ships	276
Utility Vessels	5,235
TOTAL	**55,002**

a Includes steel hulled vessels only.

COST ESTIMATES

Consistent with information obtained while developing the 2008 VGP, EPA assumes that there are no incremental costs to vessels for implementing cathodic protection on applicable vessels since steel hulled vessels generally have either an ICCP or a sacrificial electrodes system of cathodic protection (EPA, 2008a). EPA expects that this is also the case for steel hulled commercial fishing vessels newly covered by the 2013 VGP.

Practices aimed at preventing potential hotspots for fouling organisms (anodes to be flush-fitted to the hull or a backing to be inserted in the space between the anode and the hull) are assumed to already be implemented and therefore do not represent incremental costs on vessel owners.

A sensitivity analysis was performed to estimate potential costs of cathodic protection installation for vessels that will opt to purchase an ICCP system in accordance with the Permit recommendations. In the sensitivity analysis EPA has estimated a potential low and high incremental cost associated with cathodic protection installation. These low and high estimates are based upon the percentage of vessels that may need to install an updated system.

Practices associated with maintenance and replacement of the cathodic protection system will not incur incremental costs, and no sensitivity analysis is performed since these practices are regularly performed when deemed necessary.

Finally, documentation of the anode selection is anticipated to represent a minimal additional burden for the subset of vessel owners that use aluminum or zinc, relative to the annual paperwork burden discussed in *Section 4.4*.

SENSITIVITY ANALYSIS

Costs of installing either an ICCP or a sacrificial electrodes system of cathodic protection were estimated based upon communication with a cathodic protection manufacturing company (see EPA, 2008a). The cost input values of cathodic protection system installation are shown in *Table 4-17* (escalated to 2010 dollars), and the estimates/assumptions derived for each practice are described below.

Table 4-17. Cathodic Protection Installation Cost Estimates (2010$).

Vessel Class	Low End Installation Cost	High End Installation Cost	Average Installation Cost
Commercial Fishing	$16,574	$19,889	$18,232

- *Installation Costs:* Cost estimates were obtained from a representative from a cathodic protection manufacturing company. The figures are dependent upon the area of steel on the hull as well as other minor components. Commercial fishing vessels are assumed to have costs similar to those of freight ships. The cost estimates shown in *Table 4-17* were originally provided in 2008 dollars and escalated to 2010 dollars using the consumer cost index from the Bureau of Labor Statistics.

- *Baseline:* For the low end estimate, EPA assumes that no commercial fishing vessel will install an ICCP system due to the Permit recommendations. For the high end estimate, the fraction is assumed to be 5 percent.
- *Equipment Life*: The ICCP system is expected to last for the lifetime of the vessel. Thus, the total incremental cost of the device is annualized at a 7 percent discount rate over 30 years to estimate the annual cost per vessel presented in *Table 4-18.*

The cost per vessel and the total cost associated with all vessels are presented in *Table 4-18.* At the low end, there is no incremental cost. At the high end, if 5 percent install an ICCP system, the potential incremental cost is approximately $144,500.

Table 4-18. Cathodic Protection Sensitivity Analysis, Purchase of a Cathodic Protection System.

Vessel Class	Vessel Count[a]	% Vessels Needing to Purchase System	Annual Cost per Vessel[b]	Total Annual Cost
Low End Estimate				
Commercial Fishing	1,967	0%	$1,469.22	$0
Low End TOTAL	**1,967**			**$0**
High End Estimate				
Commercial Fishing	1,967	5%	$1,469.22	$144,496
High End TOTAL	**1,967**			**$144,496**

a Applies to steel hulled vessels only.

b Annualized at a 7% discount rate over 30 years.

4.2.8 CHAIN LOCKER EFFLUENT

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to chain locker effluent discharges are found in only a subset of vessel classes. The practices in this category are applicable to freight ships, tank ships, and various utility vessels; they do not apply to the other vessel classes because their anchors are rarely or never deployed or other equipment is used (e.g., anchor cable). Since the 2013 VGP requirements are unchanged from current practices and since chain locker effluent discharges are not applicable to newly covered commercial fishing vessels, no vessel is assumed to incur incremental cost as a result of the 2013 permit.

Furthermore, EPA's analysis of the 2008 VGP had found that most practices in the chain locker effluent discharge category were already implemented by the industry even before the VGP was promulgated (EPA, 2008a). For vessel types to which the discharge category applies, EPA had performed a sensitivity analysis only for the potential incremental costs associated with washing down the anchor chain as it is being hauled out of the water. In the sensitivity analysis EPA estimated a potential low and high incremental cost associated with washing down the anchor chain ranging from $0 to $4.74 per vessel per year (in 2008$).

4.2.9 CONTROLLABLE PITCH PROPELLER AND THRUSTER HYDRAULIC FLUID AND OTHER OIL SEA INTERFACES INCLUDING LUBRICATION DISCHARGES FROM PADDLE WHEEL PROPULSION, STERN TUBES, THRUSTER BEARINGS, STABILIZERS, RUDDER BEARINGS, AZIMUTH THRUSTERS, PROPULSION POD LUBRICATION, AND WIRE ROPE AND MECAHNICAL EQUIPMENT SUBJECT TO IMMERSION

PERMIT REQUIREMENTS

The Permit requirements to minimize the discharge of oil are generally unchanged. Under the 2013 VGP, however, all vessels must use an environmentally acceptable lubricants (EALs) in all oil to sea interfaces, unless technically infeasible.[42] If a vessel finds it is technically infeasible to use an environmentally acceptable lubricant for their vessel, the owner/operator must explain why they cannot do so in their recordkeeping documentation, and must note the use of a non-environmentally acceptable lubricant in the vessel's Annual Report.

***Permit Text**:*

The protective seals on controllable pitch propellers, azimuth thrusters, propulsion pods, rudder bearings, or any other oil-to-sea interfaces must be maintained in good operating order to minimize the leaking of hydraulic oil or other oils. The vessel owner/operator must not discharge oil in quantities that may be harmful as defined in 40 CFR Part 110 from any oil-to-sea interface. If possible, maintenance activities on controllable pitch propellers, thrusters, and other oil-to-sea interfaces should be conducted when a vessel is in drydock.

Minimize maintenance activities on stern tube seals when a vessel is outside of drydock. If maintenance or emergency repair must occur on stern tubes or other oil-to-sea interfaces which have a potential to release oil in quantities that may be harmful as defined in 40 CFR Part 110, appropriate spill response equipment (e.g., oil booms) must be used to contain any oil leakage. Operators of the vessel must have ready access to spill response resources to clean up any oil spills.

After applying lubrication to wire rope and mechanical equipment subject to immersion, wire ropes, and other equipment must be thoroughly wiped down to remove excess lubricant unless doing so is deemed unsafe by the Master of the vessel.

All vessels must use an EAL in all oil to sea interfaces, unless technically infeasible. "Environmentally acceptable lubricants" means lubricants that are "biodegradable" and "minimally-toxic" and are "not bioaccumulative" as defined in Appendix A of this permit. For purposes of requirements related to EALs, technically infeasible means that no EAL products are approved for use in a given application that meet manufacturer specifications for that equipment,

[42] Part 7 of the permit defines environmentally acceptable lubricants to denote a lubricant that is biodegradable, exhibits low toxicity to aquatic organisms and has a low potential for bioaccumulation.

products which come pre- lubricated (e.g., wire ropes) have no available alternatives manufactured with EALs, products meeting a manufacturers specifications are not available within any port in which the vessel calls, or change over and use of an EAL must wait until the vessel's next drydocking.

If a vessel is unable to use an EAL, you must document in your recordkeeping documentation consistent with Part 4.2 why you are unable to do so, and must report the use of a non-environmentally acceptable lubricant to EPA in your Annual Report. Use of an environmentally acceptable lubricant does not authorize the discharge of any lubricant in a quantity that may be harmful as defined in 40 CFR Part 110.

EPA recommends that all new build vessel operators endeavor to use seawater-based systems for their stern tube lubrication to eliminate the discharge of oil from these interfaces to the aquatic environment.

AFFECTED VESSEL POPULATION

As for other discharge categories, commercial fishing vessels which are newly covered under the 2013 VGP may incur incremental costs of all practices contained under this category, while other vessel types are already complying with the 2008 VGP and only incur incremental costs, if any, associated with the revised requirements to use environmentally acceptable lubricants.

Based on the description of practices within this discharge category, all vessels have the potential to discharge oil due to oil-to-sea interface and a subset of vessel classes, including commercial fishing vessels, freight ships, tank ships, and various utility vessels have the potential to discharge controllable pitch propeller hydraulic fluid. No other vessel classes are expected to operate controllable pitch propellers.

In establishing this requirement for vessels, EPA considered the processes employed and potential changes which might be necessary by some vessels to use EALs. Many existing vessels can use EALs which are compatible with their existing equipment. However, the requirement is specified as to be only required where technically feasible. EPA expects that it will be technically feasible for a significant portion of vessel operators to use EALs, particularly for new build vessels during this permit term. This recognizes the possibility that while it is technically feasible for many existing vessels to use EALs, it might not be technically feasible for these vessels to use EALs with all existing equipment, that EALs may not be available within any port in which the vessel calls, or that change over and use of EAL may need to wait until the vessel's next drydocking. In contrast, new build vessels can select equipment during design and construction which is compatible with EALs for most oil-to-sea applications. Furthermore, vessel owner/operators can design additional onboard storage area for EALs if they choose to use traditional mineral based oil for engine lubrication (thereby needing two types of oils on-hand). Extra storage area needed would be minor. Nonetheless, in the event that specific vessel oil-to-sea applications do not allow for use of EALs (e.g., propulsion pods, thrusters classed for dynamic positioning; azimuthing thrusters), EPA has included a "unless technically infeasible" provision for new build vessels.

The vessel population potentially affected by practices applicable to this discharge category is shown in *Table 4-19.*

Table 4-19. Vessel Counts for General Oil-to-Sea Interface and Controllable Pitch Propeller Hydraulic Fluid Practices.

Vessel Class	Vessel Count (oil to sea interface)	Vessel Count (controllable pitch propeller)
Commercial Fishing	2,326	2,326
Freight Barges	39,760	-
Freight Ships	812	812
Passenger Vessels	1,970	-
Tank Barges	7,144	-
Tank Ships	332	332
Utility Vessels	6,258	6,258
TOTAL	**58,602**	**9,728**

COST ESTIMATES

Based upon the industry input to the 2008 VGP, maintenance of the controllable pitch propeller is already performed when in drydock and, when applicable, oil booms and oil absorbent pads are purchased and are in use. Therefore, requirements present in the 2008 VGP are assumed to impose no incremental costs on commercial fishing vessels newly covered by the 2013 VGP.

EPA's recommendation that all new build vessel operators endeavor to use seawater-based systems for their stern tube lubrication is intended to encourage the development of environmentally responsible practices and is not a requirement in the 2013 VGP. Therefore, it does not impose incremental costs.

The use of environmentally preferred lubricants may impose incremental costs on all covered vessels to the degree that these products are more (or less) expensive than the conventional products.

For environmentally acceptable lubricants, EPA obtained cost data from retailers of marine lubricants. Pricing data suggest a wide variability in the cost of different types of lubricants, depending on their use and formulation. On average, EPA found that EALs are 38 percent more expensive than conventional (e.g., mineral-based lubricants) although this difference is not always present and some EALs appear to be priced similarly as synthetic lubricants. These findings appear to be consistent with input from industry representatives EPA interviewed who indicated that EALs from vegetable sources are 10 percent to 50 percent more expensive than conventional lubricants but also noted that synthetic-based lubricants tend to be significantly more expensive than mineral-based lubricants (twice to four times more expensive).[43]

[43] Anecdotal estimates on cost differences between EALs and conventional lubricants varied widely. Industry representatives generally noted that EALs are more expensive than mineral-based lubricants with one industry representative offering an approximate ratio at 3 to 1.

Publicly available information on the price of EALs tends to be for retail purchases of relatively small quantities of lubricants by recreational boaters. These prices are likely to be significantly higher than the price paid by the owner of a larger vessel such as those covered by the VGP. EPA contacted several manufacturers and distributors of EALs to get information on large quantity pricing, but representatives contacted were generally unable to provide average prices or price differences between the products, noting that this type of information is proprietary. One industry representative offered an illustrative example of the price difference between EALs and conventional lubricants with the unit price for a standard lubricant ($7.80/gallon) being half that of the equivalent biodegradable, vegetable-based product ($15.40/gallon).[44]

Information on average consumption of lubricants by different types of vessels was similarly difficult to obtain from published sources or directly from vessel owners with industry representative noting that the quantities vary widely across vessels.

In one published study, Etkin (2010) estimated the volume of oil leaks from vessels based on prior studies and five years of data of in-port lubricant replacement rates from a lubricant supplier. Sources of operational discharges discussed in the study include deck machinery and in-water (submerged) machinery such as stern tube bearings, thruster gearboxes, and horizontal stabilizers. The data show leak rates that vary by vessel type, condition, age, and maintenance. The average daily stern tube lubricant consumption rate across vessel types is reported as 2.6 liters per day, but ranges from less than 1 liter per day to 20 liters per day. The highest average rate is associated with barge carriers while several utility vessels (e.g., patrol vessel, dredger) and fishing vessels had rates in the lower end of the range. In addition to stern tube leakage, Etkin (2010) also provides estimates of lubricant leakage from deck machinery and in-water submerged machinery. Consumption of oil used as lubricant in-water submerged applications is estimated to range between 1 and 29 liters per port visit, depending on the type of vessel. Values derived from Etkin (2010) are within the range of annual consumption estimates EPA was gathered anecdotally from industry representative for different types of vessels.

For the sensitivity analysis presented below, EPA used the illustrative average oil consumption rates due to leakage and illustrative incremental costs to estimate potential incremental costs to vessel owners for replacing conventional lubricants with EALs in all oil-to-sea interfaces.

SENSITIVITY ANALYSIS

Consumption estimates are based on values presented in Etkin (2010) as summarized in *Table 4-20*. These estimates represent consumption of lubricants due to leakage. To the degree that they do not account for replacement of oil remaining in the various systems, these values may underestimate total lubricant consumption.

[44] The products are considered to offer similar performance and characteristics. Note that EALs may offer performance advantages over mineral-based oils: information obtained from another manufacturing company representative suggests that EALs may provide measurable performance advantages, including an extended life (50 to 100 percent increase is reported) when compared to conventional mineral-based oils.

Table 4-20: Lubricant Consumption Rates by Vessel Class.

Vessel Class	Consumption rate for stern tube bearing (liters/day)	Consumption rate for all other submerged equipment (liters/day)	Total (liters/day)	Total (gallons/day)	Total (gallons/year)[a]
Commercial Fishing	2.0	3.0	5.0	1.3	121
Freight Barges	-	1.0	1.0	0.3	24
Freight Ships	7.0	7.0	14.0	3.7	337
Passenger Vessels	2.0	3.3	5.3	1.4	128
Tank Barges	-	1.0	1.0	0.3	24
Tank Ships	5.0	1.5	6.5	1.7	157
Utility Vessels	1.5	6.0	7.5	2.0	181

Source: Etkin (2010). Consumption rates are attributed to each vessel class based on the average rates for corresponding types of vessel presented in Etkin (2010).

a Assumes that consumption while in port covers days when vessels are traveling between ports. Vessels are assumed to spend 3 days in travel for each day in port.

The sensitivity analysis also uses the following assumptions.

- *Lubricant Costs:* A wide range of lubricants are used in marine applications with very diverse prices and quantities used. EPA was not able to obtain specific data on the relative consumption rates of different categories of lubricants by vessels covered by the VGP. As an upper bound estimate of the potential incremental cost, EPA assumed a price difference of 120 percent, based on the illustrative example provided by one industry representative ($15.40 per gallon vs. $7.80 per gallon). For the lower bound estimate, EPA assumed a 50 percent difference in price, based on EPA's review of retail prices for different types of lubricants marketed for marine application, which found an average price difference of 38 percent. The same baseline price of $7.80 per gallon was assumed for both the low and high bound estimates, based on the illustrative example discussed earlier in this section. The incremental cost incurred by a vessel owner is therefore assumed to range between $4 and $8 per gallon. This incremental cost is based on prices charged in major U.S. ports; regional prices may differ from this average. For example, commenters have noted that the costs of EALs are considerably higher in certain, more remote areas of Alaska. EPA reviewed the number of vessels with hailing ports located in Alaska and found that these vessels represent a relatively small fraction (about 1 percent) of the universe of vessels covered by the VGP. Further larger vessels that travel over long distances may have greater flexibility in purchasing supplies in locations where they are cheapest. For these reasons, national-level cost estimates may be appropriate for most vessels. EPA does recognize, however, that some vessel owners could incur higher costs.
- *Baseline:* As low end estimate, EPA assumed that 5 percent of existing and 10 percent of new vessels use EALs (or alternatively, EALs represent 2.5 percent and 5 percent of

lubricant uses) in the baseline. As high end estimate, EPA assumed that only 2.5 percent of existing vessels and 5 percent of new vessels use EALs.

- *Implementation Rate:* As low end estimate, EPA assumed that all 90 percent of new vessels and 50 percent of existing vessels would replace their existing lubricants with EALs while for the high end estimate, EPA assumed that 100 percent of new vessels and 75 percent of existing vessels would do so.

The cost per vessel for each practice and the total cost associated with all vessels are provided in *Table 4-21.*

Table 4-21. Environmentally Acceptable Lubricants Sensitivity Analysis.

Vessel Class	Vessel Count[a]	% Vessels where Practice is Applicable[b]	Annual Cost per Vessel	Total Annual Cost
Low End Estimate (Average Incremental Cost $4/gallon)				
Use EAL				
Commercial Fishing	2,326	48%	$482	$535,944
Freight Barges	39,760	48%	$96	$1,821,277
Freight Ships	812	48%	$1,350	$531,425
Passenger Vessels	1,970	48%	$514	$483,788
Tank Barges	7,144	48%	$96	$327,697
Tank Ships	332	48%	$627	$101,011
Utility Vessels	6,258	48%	$723	$2,181,334
Low End TOTAL	**58,602**		**$214**	**$5,982,476**
High End Estimate (Average Incremental Cost $8/gallon)				
Use EAL				
Commercial Fishing	2,326	73%	$964	$1,643,424
Freight Barges	39,760	73%	$193	$5,607,112
Freight Ships	812	74%	$2,700	$1,613,887
Passenger Vessels	1,970	73%	$1,028	$1,483,738
Tank Barges	7,144	73%	$193	$1,007,955
Tank Ships	332	74%	$1,254	$306,639
Utility Vessels	6,258	73%	$1,446	$6,651,332
High End TOTAL	**58,602**		**$427**	**$18,314,088**

a Existing and new vessels, assuming that vessels are replaced at the rate of 1/30[th] of the population each year.

b Fraction represents the combination of assumptions on the fraction of new and existing vessels that implement the practice in the baseline and those anticipated to use EALs under the 2013 VGP.

4.2.10 DISTILLATION AND REVERSE OSMOSIS BRINE

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to discharges of distillation and reverse osmosis brine have negligible costs and/or the industry is assumed to currently practice the Permit requirements. This discharge category is assumed to have zero incremental cost.

4.2.11 ELEVATOR PIT EFFLUENT

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that these vessels typically do not have elevator pit effluent. They do not incur an incremental cost as a result of their VGP coverage and this discharge category therefore is assumed to have zero incremental cost.

4.2.12 FIREMAIN SYSTEMS

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that firemain systems are uncommon on commercial fishing vessels and these vessels therefore do not incur an incremental cost as a result of their VGP coverage. This discharge category is assumed to have zero incremental cost.

4.2.13 FRESHWATER LAYUP

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that freshwater layup discharges are uncommon to commercial fishing vessels and these vessels therefore do not incur an incremental cost as a result of their VGP coverage. This discharge category is assumed to have zero incremental cost.

4.2.14 GAS TURBINE WASH WATER

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that gas turbine wash water discharges are generally not present on commercial fishing vessels and these vessels therefore do not incur an incremental cost as a result of their VGP coverage. This discharge category is assumed to have zero incremental cost.

4.2.15 GRAYWATER

Graywater is defined in the Vessel General Permit as the discharge derived from “galley, bath and shower water, as well as wastewater from lavatory sinks, laundry, and water fountains” (EPA, 2010a). The 2008 VGP contains a number of special provisions applying to discharges of graywater from cruise ships, specifying treatment standards for graywater discharges in port or within 1 nm of shore, and requiring that releases between 1 and 3 nm of shore occur only when traveling at a speed of at least 6 knots. These requirements were established based on the U.S. Coast Guard Limitations on Discharge of Treated Sewage or Graywater in Alaska, promulgated in 2001 (33 CFR 159). Even before the 2008 VGP was finalized, several other states had existing requirements for graywater discharges. For example, Maine adopted Alaska's discharge requirements for vessels with passenger capacities of at least 250 under the 2003 Act to Protect Maine's Coastal Waters and the California Clean Coast Act, enacted in 2004, prohibits cruise ships from discharging any graywater into California's territorial waters. Additionally, several states, including Washington, Hawaii, and Florida, had voluntary memoranda of understanding with the cruise ship industry that discourage the discharge of untreated graywater in port or within 4 nm of shore.[45]

Also relevant to graywater discharges are two other federal regulations. First, under Section 312(a) of the CWA, graywater discharges from commercial vessels in the Great Lakes region are currently treated as sewage and thus are excluded from the scope of the VGP. Second, the National Marine Sanctuaries Act authorizes the National Oceanic and Atmospheric Administration (NOAA) to designate National Marine Sanctuaries wherein certain discharges, including graywater, may be restricted to protect sensitive ecosystems.

PERMIT REQUIREMENTS

The 2013 VGP generally maintains graywater requirements contained in the 2008 VGP but additionally requires that any vessel constructed on or after December 19, 2013 which provide overnight accommodation to at least 10 crew and any vessel operating on the Great Lakes that is not a "commercial vessel" comply with additional requirements. If they discharge graywater, these vessels must conduct monitoring. Effluent limits for non "commercial vessels" (as defined in CWA Section 312(a)(10)) operating on the Great Lakes are specified as no more than 200 cfu/100 ml fecal coliform and no more than 150 mg/l of suspended solids

Part 2.2.15.2 of the 2013 VGP states that samples must be taken for BOD, fecal coliform, suspended solids, pH, and total residual chlorine, and that sampling must be conducted in accordance with the 40 CFR Part 136 methods. Samples taken from non-commercial vessels operating on the Great Lakes must meet the standards specified in Part 2.2.15.1 of the permit, which pertain to fecal coliform and suspended solids. Records of monitoring information must include the date, exact place, and time of sampling/measurements, the individual(s) who performed the sampling/measurements, the date(s) the analyses were performed, the individual(s) who performed the analyses, the analytical techniques/methods used, and the results of such analyses.

All records of the sampling and testing results must be retained onboard in the vessel's recordkeeping documentation for 3 years.

***Permit Text**:*

2.2.15 Graywater

All vessels must minimize the discharge of graywater while in port. For those vessels that cannot store graywater, the owner or operator and their crews must minimize the production of graywater in port. Examples of ways to minimize production of graywater include delaying laundry, scullery activities, and restricting length of showers while in port, and using high efficiency faucets and showerheads. All vessels that have the capacity to store graywater shall not discharge it in waters listed in Appendix G. For vessels that cannot store graywater, vessel operators must minimize the production of graywater while in waters listed in Appendix G.

For vessels greater than 400 gross tons that regularly travel more than 1 nm from shore that have the capacity to store graywater for a sufficient period, graywater must be discharged greater than 1 nm from shore while the vessel is underway, unless the vessel meets the treatment standards and other requirements contained under Parts 5.1.1 and 5.1.2 or 5.2.1 and 5.2.2 of this permit. Additional specific requirements for graywater apply to cruise ships (Parts 5.1 and 5.2) and large ferries (Part 5.3).

Vessels that do not travel more than 1 nm from shore shall minimize the discharge of graywater and, provided the vessel has available graywater storage capacity, must dispose of graywater onshore if appropriate facilities are available and such disposal is economically practicable and achievable unless the vessel meets the treatment standards and other requirements contained under Parts 5.1.1 and 5.1.2 or 5.2.1 and 5.2.2 of this permit. You must also minimize the discharge of graywater when the vessel is not underway.

If graywater will be discharged in waters subject to this permit, the introduction of kitchen oils to the graywater system must be minimized. When cleaning dishes, you must remove as much food and oil residue as practicable before rinsing dishes. Excess oils used in cooking, including animal fats and vegetable oils, shall not be added to the graywater system. Under no circumstances may oil from the galley and scullery be discharged in quantities that may be harmful as defined in 40 CFR Part 110.

Vessel owners/operators must use phosphate-free and minimally-toxic soaps and detergents, as defined in Appendix A of this permit, for any purpose if graywater will be discharged into waters subject to this permit. Soaps and detergents must be free from toxic or bioaccumulative compounds and not lead to extreme shifts in receiving water pH. For purposes of this part, extreme shifts means causing pH to fall below 6.0 or rise above 9.0 as a direct result of the discharge.

If your vessel is underway in a nutrient-impaired water, or a water that is impaired as a result of nutrient enrichment (such as waters listed as impaired for phosphorus, nitrogen, or for hypoxia or anoxia [low dissolved oxygen concentrations]), you must follow these additional requirements:

When the vessel has adequate graywater storage capacity, the vessel owner/operator shall not discharge graywater into nutrient-impaired waters subject to this permit (e.g., the Chesapeake Bay). A complete list of such waters can be found at www.epa.gov/npdes/vessels. Where the *vessel does not have adequate storage capacity to eliminate such discharges, graywater production and discharge must be minimized in such waters. Any such discharge must be conducted while the vessel is underway in areas with significant circulation and depth to the extent feasible. Graywater stored while in such waters can later be disposed of onshore or discharged in accordance with the other requirements of this permit.*

2.2.15.1 Additional Graywater Requirements for Certain VGP Vessels Operating in the Great Lakes

Any vessel operating on the Great Lakes that is not a "commercial vessel" as defined in CWA section 312(a)(10) must meet one of the following requirements for graywater management:

(i) The vessel must hold all graywater for onshore discharge to an appropriate shoreside facility (an appropriate shoreside facility is either an NPDES permitted facility or an entity that delivers wastewater directly to an NPDES permitted facility); or

(ii) The graywater discharge must not exceed 200 fecal coliform forming units per 100 milliliters and contain no more than 150 milligrams per liter of suspended solids.

Vessels subject to this part must conduct monitoring required under Part 2.2.15.2 to demonstrate treatment equipment maintenance and compliance with the limits of this part. Records of the sampling and analysis results must be retained onboard for at least 3 years in the vessel's recordkeeping documentation consistent with Part 4.2 of this permit.

2.2.15.2 Graywater Monitoring

The following monitoring requirements are applicable to vessels which discharge graywater into waters subject to this permit and meet one of the following conditions:

- *The vessel is a new build vessel constructed on or after December 19, 2013, has a maximum crew capacity greater or equal to 14, and provides overnight accommodations to those crew; or*
- *The vessel is subject to Part 2.2.15.1 of this permit.*

Vessel owners/operators must collect and analyze two samples per year, collected at least 14 days apart, and report the results of those samples as part of their Annual Report. Samples must be taken for Biochemical Oxygen Demand (BOD), fecal coliform, suspended solids, pH, and total residual chlorine. Vessel owner/operators may choose to conduct monitoring for e. coli in lieu of fecal coliform. Fecal Coliform or e. coli must only be analyzed once per year if vessels have difficulty analyzing the results within recommended holding times. Sampling and testing shall be conducted according to 40 CFR Part 136. If the vessel is subject to Part 2.2.15.1, measured samples must meet the standards specified in that part.

Records of monitoring information shall include:

- *The date, exact place, and time of sampling or measurements;*
- *The individual(s) who performed the sampling or measurements;*
- *The date(s) analyses were performed;*
- *The individual(s) who performed the analyses;*

- *The analytical techniques or methods used; and*
- *The results of such analyses.*

Vessels subject to this part must note whether the graywater effluent is treated or untreated, and also note whether the effluent is graywater alone or if it is mixed with another effluent type (e.g., graywater mixed with sewage). Records of the sampling and testing results must be retained onboard for at least 3 years in the vessel's recordkeeping documentation consistent with Part 4.2.

Vessels which do not enter waters subject to this permit for the calendar year need not conduct monitoring for that year, but must clearly indicate on their Annual Report that they did not enter waters subject to this permit during that year.

AFFECTED VESSEL POPULATION

Practices related to graywater discharges are potentially applicable to every vessel class except for freight barges and tank barges (as those vessels do not produce graywater). All applicable vessels with the exception of commercial fishing vessels are assumed to currently implement the 2008 VGP requirements; unchanged 2013 VGP requirements potentially represent an incremental cost for owners of commercial fishing vessels.

Additional graywater monitoring requirements apply to certain vessels. NOIs received by EPA to date show that 1 percent of vessels overall use onboard treatment for their graywater, with the largest share of vessels using graywater treatment being large and medium cruise ships, followed by large ferries. The revised requirements are not expected to change current practices, as vessels that currently hold their graywater are expected to continue doing so. Characteristics of vessels that had submitted an NOI as of August 2010 suggest that 10 percent of existing passenger vessels use graywater treatment. Smaller fractions of tank ships and freight ships (2 percent) and commercial fishing vessels and utility vessels (1 percent) have graywater treatment onboard. In the aggregate, an estimated 11,698 vessels are assumed to implement onboard graywater treatment in the baseline.

In addition, the 2013 VGP requires certain new build vessels that discharge graywater to comply with monitoring requirements. New build vessels subject to the monitoring requirements are those constructed on or after December 19, 2013, with maximum crew capacity greater or equal to 10, and overnight accommodations for those crew. Except for barges which provide no crew accommodation, and utility vessels where EPA assumed that about a quarter meet the criteria, all new vessels are assumed to potentially be subject to the graywater monitoring requirements. The number of new vessels in each class was estimated at 1/30th of the vessel population, based on an assumed vessel life of 30 years.

New requirements for non "commercial vessels" (as defined in CWA Section 312(a)(10)) that travel in the Great Lakes are applicable to any vessel that is not "used in the business of transporting property for compensation or hire, or in transporting property in the business of the owner, lessee, or operator of the vessel." (33 U.S.C. 1322 (a)(10)). EPA has included the requirement so that there is no ambiguity that any non-recreational, non-military vessel greater than 79 feet is expected to treat or hold their graywater when operating on the Great Lakes. Numerous vessels are considered "commercial vessels" under Section 312(a)(10) of the Clean

Water Act and currently either hold their graywater for onshore disposal at a sewage treatment plant or treat that graywater using an existing Marine Sanitation Device. Hence, holding capacity is present on some vessels or treatment devices are available and used for managing graywater from vessels operating on the Great Lakes and EPA believes most, if not all, VGP eligible vessels operating on the Great Lakes should already be meeting these conditions.

The population potentially affected by revisions to requirements applicable to the graywater discharge category is shown in *Table 4-22.*

Table 4-22. Vessel Counts for Graywater Practices.

Vessel Class	Number of Existing Vessels	Fraction of Existing vessels [a]	Total Existing Vessel Count	Total New Vessel Count (low estimate)[b]	Total New Vessel Count (high estimate)[c]
Commercial Fishing	2,326	1%	33	98	195
Freight Barges	39,760	0%	-	-	-
Freight Ships	812	2%	13	51	68
Passenger Vessels	1,970	10%	92	149	165
Tank Barges	7,144	0%	-	-	-
Tank Ships	332	2%	5	21	28
Utility Vessels	6,258	1%	63	52	131
TOTAL	**58,602**		**206**	**370**	**586**

[a] Fractions are based on characteristics of vessels that submitted an NOI.

[b] Average number of new vessels subject to the requirements is estimated based on replacement of 1/30th of the vessel population each year during over the 5-year permit. 75% of commercial fishing, freight ships, tank ships, and passenger vessels are assumed to potentially discharge graywater, while 10% of utility vessels are assumed to provide overnight accommodation for at least 10 crews.

[c] Average number of new vessels subject to the requirements is estimated based on replacement of 1/30th of the vessel population each year during over the 5-year permit. All commercial fishing, freight ships, tank ships, and passenger vessels are assumed to potentially discharge graywater, while a quarter of utility vessels are assumed to provide overnight accommodation for at least 10 crews.

[d] The number of passenger vessels is adjusted to account for the 113 passenger vessels (cruise ships) previously estimated to comply with the treatment requirements in the 2008 VGP analysis (see EPA, 2008a)

COST ESTIMATES

Additional monitoring requirements for vessels that discharge treated graywater have the potential to impose incremental compliance cost on the owners of these vessels. Monitoring requirements are similar to those contained in the 2008 VGP for medium and large cruise ships, except for their lower annual frequency. Costs for implementing the monitoring requirements are estimated at $201 per monitoring event, which covers analytical testing ($137 for all four parameters), sampling, administration, and reporting (one labor hour at an assumed average hourly rate of $33.72), and incidental expenses such as shipping ($30).

SENSITIVITY ANALYSIS

The sensitivity analysis uses the following assumptions.

- *Monitoring Costs:* Per event costs are assumed to be $201, inclusive of all labor and material.
- *Baseline:* EPA assumed that all cruise ships for which the requirement applies currently comply with the vessel type specific requirements in the 2008 VGP and therefore will not incur incremental costs as a result of the revised graywater requirements for all vessel types. The fraction of vessels that may treat rather than hold their graywater is assumed based on vessel characteristics from NOIs received by EPA as of August 2010.
- *Implementation Rate:* EPA assumed that 100 percent of applicable vessels will need to conduct the additional monitoring.

The cost per vessel for each practice and the total cost associated with all vessels are provided in *Table 4-21*.

Table 4-23. Graywater Monitoring Sensitivity Analysis.

Vessel Class	Existing Vessel Count[a]	New Vessel Count	Annual Cost per Vessel	Total Annual Cost
Low End Estimate				
Monitor Graywater				
Commercial Fishing	33	98	$201	$26,207
Freight Barges	-	-	$201	$0
Freight Ships	13	51	$201	$12,777
Passenger Vessels	92	149	$201	$48,297
Tank Barges	-	-	$201	$0
Tank Ships	5	21	$201	$5,146
Utility Vessels	63	52	$201	$23,145
Low End TOTAL	**206**	**370**		**$115,572**
High End Estimate				
Monitor Graywater				
Commercial Fishing	33	195	$201	$45,787
Freight Barges	-	-	$-	$0
Freight Ships	13	68	$201	$16,166
Passenger Vessels	92	165	$201	$51,611
Tank Barges	-	-	$-	$0
Tank Ships	5	28	$201	$6,527
Utility Vessels	63	131	$201	$38,884
High End TOTAL	**206**	**586**		**$158,974**

a For passenger vessels, the number of vessels that have incremental cost is further adjusted by removing the large and medium cruise ships assumed to already be implementing monitoring requirements under the 2008 VGP.

4.2.16 MOTOR GASOLINE AND COMPENSATING DISCHARGE

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to motor gasoline and compensating discharges have negligible costs and/or the industry is assumed to currently practice the Permit requirements (e.g., in compliance with the oil discharge prohibition in 40 CFR part 110). This discharge category is assumed to have zero incremental cost.

4.2.17 NON-OILY MACHINERY WASTEWATER

The 2013 VGP requirements are identical to the 2008 VGP requirements, except for minor editorial changes to describe the type of wastewater associated with this category (i.e., non-oily wastewater, technical water, or potable water). Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to non-oily machinery wastewater discharges have negligible costs and/or the industry is assumed to currently practice the Permit requirements (e.g., in compliance with the oil discharge prohibition in 40 CFR part 110). This discharge category is assumed to have zero incremental cost.

4.2.18 REFRIGERATION AND AIR CONDENSATE DISCHARGE

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to refrigeration and air condensate discharges have negligible costs and/or the industry is assumed to currently practice the Permit requirements (e.g., in compliance with the oil discharge prohibition in 40 CFR part 110). This discharge category is assumed to have zero incremental cost.

4.2.19 SEAWATER COOLING OVERBOARD DISCHARGE (INCLUDING NON-CONTACT ENGINE COOLING WATER, HYDRAULIC SYSTEM COOLING WATER, REFRIGERATION COOLING WATER)

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to seawater cooling overboard discharges have negligible costs and/or the industry is assumed to currently practice the Permit requirements (e.g., in compliance with the oil discharge prohibition in 40 CFR part 110). This discharge category is assumed to have zero incremental cost.

4.2.20 SEAWATER PIPING BIOFOULING PREVENTION

The 2013 VGP requirements for this discharge category are fundamentally similar to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to seawater piping biofouling prevention discharges have negligible costs and/or the industry is assumed to currently practice the Permit requirements (e.g., in compliance with the oil discharge prohibition in 40 CFR part 110). This discharge category is assumed to have zero incremental cost.

4.2.21 BOAT ENGINE WET EXHAUST

The Permit updates the 2008 VGP to require that vessels with two-stroke engines use environmentally acceptable lubricants.

***Permit Text**:*

2.2.21 Boat Engine Wet Exhaust

Vessel engines generating wet exhaust must be maintained in good operating order, well tuned, and function according to manufacturer specifications to decrease pollutant contributions to wet exhaust. Vessel owner/operators should use low sulfur or alternative fuels for their vessels to reduce the concentration of pollutants in discharges from boat engine wet exhaust.

EPA encourages vessel operators to consider four stroke engines instead of two stroke engines for vessels generating wet exhaust that are covered under this permit. Use of a four stroke engine may minimize the discharge of pollutants to waters subject to this permit. Where vessels utilize two stroke engines, environmentally acceptable lubricants (as defined in Appendix A of this permit) must be used unless technologically infeasible. If technologically infeasible, the vessel owner/operator must document in their recordkeeping documentation why they are not using environmentally acceptable lubricants.

AFFECTED VESSEL POPULATION

No information is available from the combined MISLE/WTLUS database to determine the number of vessels that currently use two-stroke engines. Newly covered commercial fishing vessels are potentially impacted by the requirements pertaining to small boat engine wet exhaust; certain existing vessels that use two strokes engines may be affected by the additional requirements to use environmentally acceptable lubricants. However, as discussed in the next section, neither the baseline nor the revised requirements are expected to represent incremental costs for these vessels. EPA therefore did not determine the size of the relevant vessel population.

COST ESTIMATES

General practices relating to equipment maintenance and low sulfur fuels are assumed to already be implemented by vessel owners, including those in the fishing industry. EPA reviewed prices for different types of engine lubricants including EALs and mineral-based products and found no systematic difference in the unit cost of these products that would suggest that using EALs would result in additional costs for vessel owners; in fact some EAL products were less expensive than petroleum-based lubricants.[46] Accordingly, EPA estimates that revisions of requirements for this discharge category have no incremental cost.

4.2.22 SONAR DOME DISCHARGE

The 2013 VGP requirements are fundamentally identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to sonar dome discharges have negligible costs and/or the industry is assumed to currently practice the Permit requirements. This discharge category is assumed to have zero incremental cost.

4.2.23 UNDERWATER SHIP HUSBANDRY AND HULL FOULING DISCHARGES

PERMIT REQUIREMENTS

The 2013 VGP retains the requirements of the 2008VGP with minor clarifications on practices to minimize the impacts of ship husbandry and hull fouling discharges.

Permit Text:

2.2.23 Underwater Ship Husbandry Discharges

Vessel owners/operators must minimize the transport of attached living organisms when traveling into U.S. waters from outside the U.S. economic zone or between Captain of the Port (COTP) zones. Management measures to minimize the transport of attached living organisms include selecting an appropriate anti-foulant management system and maintaining that system, in water inspection, cleaning, and maintenance of hulls, and thorough hull and other niche area cleaning when a vessel is in drydock.

Whenever possible, rigorous hull-cleaning activities should take place in drydock, or at a land-based facility where the removal of fouling organisms or spent antifouling coatings paint can be contained. If water-pressure-based systems are used to clean the hull and remove old paint, you must use facilities which treat the washwater prior to discharging to waters subject to this permit in order to remove the antifouling compound(s) and fouling growth from the washwater. If mechanical means (scraping, etc.) are used to clean the hull and remove old paint, the materials removed from the hull during that process must be collected and disposed of properly (e.g., onshore). These materials must not be allowed to contaminate nearby waters.

[46] The average cost per gallon for environmentally acceptable two-stroke engine oil was approximately $23 as compared to average cost of $32 for non-EAL products.

Vessel owners/operators who remove fouling organisms from hulls while the vessel is waterborne must employ methods that minimize the discharge of fouling organisms and antifouling hull coatings. These shall include:

- *Use of appropriate cleaning brush or sponge rigidity to minimize removal of antifouling coatings and biocide releases into the water column;*
- *Limiting use of hard brushes and surfaces to the removal of hard growth; and*
- *When available and feasible, use of vacuum or other control technologies to minimize the release or dispersion of antifouling hull coatings and fouling organisms into the water column.*

Vessel owners/operators must minimize the release of copper-based antifoulant paints during vessel cleaning operations. Cleaning of hull surfaces coated with copper-based antifoulant paint must not result in any visible cloud or plume of paint in the water; if a visible cloud or plume of paint develops, shift to a softer brush or less abrasive cleaning technique. A plume or cloud of paint can be noted by the presence of discoloration or other visible indication that is distinguishable from hull growth or sediment removal. Production of a plume or cloud of sediment or hull growth is normal in some cases during vessel hull cleaning, but this plume or cloud must be substantially paint free (e.g., paint should not be clearly identifiable in the plume or cloud). When feasible, attempts must be made to minimize the release of fouling organisms and antifouling systems (including copper-based coatings) into surrounding waters.

Vessels that use copper-based anti-fouling paint must not clean the hull in copper-impaired waters within the first 365 days after paint application unless there is a significant visible indication of hull fouling. EPA maintains a list of copper-impaired waters on its webpage at www.epa.gov/npdes/vessels. If you clean before 365 days after paint application in copper-impaired waters, you must document in your recordkeeping documentation why this early cleaning was necessary.

AFFECTED VESSEL POPULATION

The discharge category is potentially applicable to all vessels covered by the VGP. All vessels except commercial fishing vessels are already complying with existing requirements under the 2008 VGP and would only incur incremental costs, if any, from revised requirements. The newly covered commercial fishing vessels have the potential to incur incremental costs if the practices required by the Permit differ from current industry practices.

The population potentially affected by practices applicable to discharges in the underwater ship husbandry category is shown in *Table 4-24.*

Table 4-24. Vessel Counts for Underwater Ship Husbandry Practices.

Vessel Class	Vessel Count
Commercial Fishing	2,326
Freight Barges	39,760
Freight Ships	812
Passenger Vessels	1,970
Tank Barges	7,144
Tank Ships	332
Utility Vessels	6,258
TOTAL	**58,602**

COST ESTIMATES

Since practices associated with underwater ship husbandry are generally contracted to diving companies, information gathered from diving companies is most useful. In estimating the impacts of the 2008 VGP, EPA found that the requirements contained in the 2008 VGP were consistent with existing standard practices and therefore the requirements did not represent incremental costs for vessel owners. Revisions to the requirements in the 2013 VGP similarly highlight practices that EPA believes are already common, such as minimizing contamination from paint scrapings, fouling organisms or antifouling systems.

Because the circumstances are anticipated to be infrequent, documentation of cleanings conducted in copper-impaired waters within 365 days of paint application likely represents only a minimal additional burden for the subset of vessel owners affected, relative to the annual paperwork burden discussed in *Section 4.4*.

Accordingly, revisions to requirements under this discharge category are not expected to impose incremental costs on vessel owners.

4.2.24 WELLDECK DISCHARGES

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to welldeck discharges have negligible costs and/or the industry is assumed to currently practice the Permit requirements. This discharge category is assumed to have zero incremental cost.

4.2.25 GRAYWATER MIXED WITH SEWAGE FROM VESSELS

The 2013 VGP requirements are identical to the 2008 VGP requirements. Therefore, the only vessels that are potentially impacted by this section are commercial fishing vessels as all other vessels currently covered by the 2008 VGP are assumed to comply with applicable requirements. However, EPA has determined that practices applicable to discharges of graywater mixed with sewage have negligible costs and/or the industry is assumed to currently practice the Permit requirements. This discharge category is assumed to have zero incremental cost.

4.2.26 EXHAUST GAS SCRUBBER WASHWATER DISCHARGE

In the 2013 VGP, is proposing several monitoring requirements for those vessels which use exhaust gas scrubber systems. These requirements are similar to those contained in the International Maritime Organization (IMO) guidelines for exhaust gas cleaning systems in resolution Marine Environmental Protection Committee (MEPC) 184(579). In addition to continuous monitoring of the washwater, vessel owners must analyze the effluent for several pollutants on a quarterly basis. The results of the monitoring must be submitted to EPA annually. Additionally, the VGP contains other requirements to assure that exhaust gas scrubber discharges are consistent with existing US law.

PERMIT REQUIREMENTS

Permit Text*:*

2.2.26 Exhaust Gas Scrubber Washwater Discharge

Exhaust gas scrubber washwater discharge must not contain oil, including oily mixtures, in quantities that may be harmful as determined in accordance with 40 CFR Part 110. Sludge or residues generated in treating exhaust gas scrubber washwater discharge must not be discharged in waters subject to this permit and must be delivered ashore to adequate reception facilities.

In addition, owner/operators of vessels with exhaust gas cleaning systems that result in washwater discharges must meet the numeric effluent limits found in Part 2.2.26.1 and the monitoring requirements found in Part 2.2.26.2 this permit. These limits are consistent with the IMO washwater guidelines set forth in section 10 for Exhaust Gas Cleaning (EGC) Systems (resolution MEPC.184(59)). Among other things, these guidelines recommend the establishment of limits for concentrations of pollutants in the effluent.

[2.2.26.1 Exhaust Gas Scrubber Treatment Standards]

2.2.26.2Exhaust Gas Scrubber Analytical Monitoring Requirements

2.2.26.2.1 Continuous Monitoring

The data recording system must comply with the guidelines in sections 7 and 8 of MEPC.184(59) and must continuously record pH, PAH (as available), and turbidity. The vessel owner/operator must continuously monitor for PAH discharges where continuous monitoring technologies (e.g., probes/analyzers) are available (availability should include the technology's robustness, reliability and ability to perform over for a minimum of two years). When the EGC system is operated in waters subject to this permit, the washwater monitoring and recording must be continuous. The values monitored and recorded must include pH, PAH (as available), turbidity, and temperature.

. . The pH electrode and pH meter must have a resolution of 0.1 pH units and temperature compensation. The electrode must comply with the requirements defined in BS 2586 or of equivalent or better performance and the meter should meet or exceed BS EN ISO 60746-2:2003.

The PAH monitoring equipment must be capable of monitoring PAH in water in a range of at least twice the discharge concentration limit given in the table above. A demonstration must be *made that the equipment operates correctly and does not deviate more than 5 percent in washwater with turbidity within the working range of the application. For those applications discharging at lower flow rates and higher PAH concentrations, ultraviolet light monitoring technology or equivalent should be used due to its reliable operating range.*

The turbidity monitoring equipment must meet requirements defined in ISO 7027:1999 or USEPA 180.1.

All continuous monitoring equipment must be calibrated as recommended by probe manufacturers or Exhaust Gas scrubber manufacturers. At a minimum, all probes must be calibrated at least annually. EPA expects many probe types (e.g., turbidity probes) will need to be calibrated on a more frequent basis.

2.2.26.2.2 Analytical Monitoring.

In addition to the continuous monitoring found in Part 2.2.26.2.1 of this permit, vessel owner/operators must collect and analyze two samples in the first year of permit coverage or system operation, whichever is first, for each of the constituents analyzed in Part 2.2.26.2.3 to demonstrate treatment equipment maintenance, probe accuracy, and compliance with this permit. Samples must not be collected within 14 days of each other. Samples must be collected for inlet water (for background), water after the scrubber (but before any treatment system), and discharge water. For all vessels, one of those samples may be conducted as part a vessel's annual or other survey, and during the first year, one of those sampling events may be conducted as part of the installation of the system to ensure it is functioning properly.

After the first year, samples must be collected at least once per calendar year for inlet water (for background), water after the scrubber (but before any treatment system), and discharge water, and may be collected as part of the vessel's annual survey as appropriate. Records of the sampling and testing results must be retained onboard for a period of 3 years in the vessel's recordkeeping documentation consistent with Part 4.2.

2.2.26.2.3 Analytes for Analytical Monitoring

Vessels conducting monitoring as required by Part 2.2.26.2.2 must monitor for the following parameters, choosing either sufficiently sensitive EPA Part 136 methods or other methods if specifically allowed:

- *Dissolved and Total Metals, including, Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Thallium, Vanadium and Zinc (recommend using EPA Methods 200.8 or 200.9 Because matrix interference is a known issue for arsenic and selenium in saltwater samples, the Agency strongly recommends operators using Octopole Reaction Cell ICP-MS, Dynamic Reaction Cell ICP-MS, hydride generation with a graphite furnace, or other appropriate approach consistent with 200.8 or 200.9 to minimize this interference);*
- *PAHs including Acenaphthylene, Acenaphthene, Anthracene Benz[a]anthracene, Benzo[ghi]perylene, Benzo[a]pyrene, Benzo[b]fluoranthene +, benzo[k]fluoranthene, Chrysene, Dibenz[a,h]anthracene, Fluoranthene, Fluorene, Indeno[1,2,3,c,d]pyrene, Naphthalene, Phenanthrene, and Pyrene (recommend using EPA Methods 550.1, 610, 625, 8100, 8270c, 8310);*

- *Nitrate-Nitrite (recommend using EPA Method 353.2);*
- *pH (using Standard Methods (SM) 4500-H B);*

2.2.26.2.4 Monitoring Reporting

Vessel owners/operators must submit all monitoring data to EPA electronically, unless exempted from electronic reporting consistent with Part 1.14 of this permit. Monitoring data must be submitted at least once per calendar year no later than February 28 of the following year on the vessel annual report. Data must be submitted on or attached to the exhaust gas scrubber DMR available in Appendix H of this permit or submitted to EPA electronically: the system is scheduled to be available at www.epa.gov/vessels/eNOI. Data may be submitted as part of the vessel's annual report.

AFFECTED VESSEL POPULATION

Vessels potentially affected by this requirement are those equipped with a marine diesel engine that use wet scrubbers or hybrid scrubbers to reduce air pollution from their gas exhaust[47] to comply with International, Federal, or regional requirements, and that discharge the washwater into waters subject to the permit.

At present, only a handful of vessels use exhaust gas cleaning systems (EGCS). With tighter air pollution regulations coming into effect and the growing availability of EGCS, however, a greater number of vessels may use EGCS in the future to reduce their SO_X emissions. No estimate could be found on the projected number of vessels that will install EGCS in coming years, and of those, the number of wet or hybrid systems that may discharge washwater. For the purpose of this analysis, EPA assumed that the number of vessels will be relatively small in the first year of the permit (i.e., 0.5 percent of freight or tank ships) but will increase to up to 10 percent of these vessels by the end of the permit period.[48]

COST ESTIMATES

In the 2013 VGP, EPA is establishing numeric BAT limits which are consistent with the international guidelines established by the IMO. Though marine gas exhaust systems are in the early stages of development, EPA has found that all marine manufacturers are designing systems with these IMO guidelines in mind and that testing of these systems onboard vessels. Furthermore, these systems are generally based on technologies that have been used in land based applications, and these technologies generally transfer well to ship-based applications. Because the limits set in the VGP are fundamentally similar to an existing international standard, treatment

[47] Other approaches to reducing air emissions include fuel conversion or switching to low-sulfur fuel.

[48] A guide developed by Ship Operations Cooperative Program (SOCP) suggests that vessels burning more than about 4,000 metric tons of fuel oil annually within emissions controls area may see cost advantages to using a EGCS instead of switching to low-sulfur fuel, depending on the cost difference between high and low-sulfur fuels and vessel-specific characteristics (space constraints, stability, areas of operation, etc.) (SOCP, 2011).

manufacturers are currently designing their equipment to meet this standard. By reinforcing existing limits, EPA is imposing no additional burden.[49]

While the numeric effluent limits are not expected to impose any incremental costs on vessel owners, EPA's requirement that vessel owners conduct analytical sampling four times per year and report the results of their continuous and periodic monitoring as part of the annual report are specific to the 2013 VGP and may represent an incremental costs.

Vessel owners are assumed to conduct continuous monitoring in accordance with IMO requirements. This includes reviewing equipment readings and calibrating probes as specified by the equipment manufacturer. No incremental cost is therefore calculated for the conduct of these activities. However, EPA assumes that vessel owners may incur up to 2 hours in additional recordkeeping burden in compiling the information as part of their annual report for each applicable vessel.

Costs for implementing the quarterly monitoring requirements are estimated at $990 per monitoring event. This cost includes analytical testing ($252) of 3 samples per event, sampling, administration, and reporting (2.5 labor hours at an assumed average hourly rate of $33.72), and incidental expenses such as shipping ($50).

SENSITIVITY ANALYSIS

The sensitivity analysis uses the following assumptions.

- *Monitoring Costs:* Per event costs are assumed to be $990, inclusive of all labor and material. Two monitoring events are conducted in the first year, and one event in each of the following four years of the permit. The additional recordkeeping burden is estimated at $67 per year (2 hours at $33.72/hour).
- *Baseline:* EPA assumed that none of the vessels equipped with EGCS would otherwise conduct the quarterly analytical sampling and testing (but would be conducting continuous monitoring). In the low end estimate, EPA assumed that up to 5 percent of freight and tank ships use an EGCS by the end of the permit period (0% in year 1; 0.5% in year 2, 1% in year 3; 2% in year 4, and 5% in year 5). For the high end estimate, EPA assumed that up to 10 percent of freight and tank ships use an EGCS by the end of the permit period (0.5% in year 1; 1% in year 2, 2% in year 3; 5% in year 4, and 10% in year 5).
- *Implementation Rate:* EPA assumed that 100 percent of applicable vessels will need to conduct the additional monitoring and recordkeeping, each year.

The cost per vessel for each practice and the total cost associated with all vessels are provided in *Table 4-25.*

[49] Additionally, vessel owner/operators may realize cost savings when using lower grade fuel (which requires use of a scrubber) compared to the higher grade, lower sulfur content fuels.

Table 4-25. Exhaust Gas Scrubber Washwater Discharge Monitoring Sensitivity Analysis.

Vessel Class	Vessel Count[a]	Annual Cost per Vessel[b]	Total Annualized Cost[c]
	Low End Estimate		
Monitor Exhaust Gas Scrubber Washwater			
Commercial Fishing	-	$0	$-
Freight Barges	-	$0	$-
Freight Ships	8	$367	$2,981
Passenger Vessels	-	$0	$-
Tank Barges	-	$0	$-
Tank Ships	3	$367	$1,220
Utility Vessels	-	$0	$-
Low End TOTAL	**11**		**$4,201**
	High End Estimate		
Monitor Exhaust Gas Scrubber Washwater			
Commercial Fishing	-	$0	$-
Freight Barges	-	$0	$-
Freight Ships	81	$396	$32,167
Passenger Vessels	-	$0	$-
Tank Barges	-	$0	$-
Tank Ships	33	$1,396	$13,161
Utility Vessels	-	$0	$-
High End TOTAL	**114**		**$45,328**

Total may not add up due to rounding.

a Represents the number of vessels that are assumed to use a EGCS by the last year of the VGP. Not all vessels incur the annual cost for each of the 5 years of the permit.

b Annual monitoring costs for a vessel that uses a wet or hybrid EGCS, including sampling, analytical tests, and incidentals.

c Costs are annualized over the 5-year permit period, accounting for the distribution of costs over time. They are calculated by annualizing (at 7 percent discount rate) the present value of estimated compliance costs for each year based on the number of domestic vessels assumed to use a wet or hybrid EGCS.

4.2.27 FISH HOLD EFFLUENT

PERMIT REQUIREMENTS

The 2013 VGP adds requirements for discharges of fish hold effluent as follows:

Permit Text:

All reasonable steps must be taken to prevent the discharge of excess fish hold water and ice while the vessel is stationary at the pier. If large solid pieces of fish waste are contained in the fish hold effluent (e.g., fish heads, internal organs) the fish hold effluent may not be discharged while the vessel is pierside and stationary, unless a physical separation method is used (e.g. ½ inch coarse screens or smaller, a screened hose having ½ inch screen openings or smaller, filters, or other methods to remove large solids).

Solid fish waste must be disposed of shoreside on land or at sea (but outside of harbors or other protected and enclosed coastal waters, and other areas where EPA has found that such deposits could endanger health, the environment, or ecological systems in a specific location under the Marine Protection, Research and Sanctuaries Act, 33 U.S.C 1412(d)).

Except for discharges from holding tanks for the sole purpose of keeping the catch alive during transit by pumping continuous "once through" ambient water into and through the tank prior to immediate discharge (e.g., crabbing/lobster vessels), if you are unloading your catch at a shore-based seafood processor or other pier and a shore-based discharge facility is available and economically achievable, you must discharge your effluent (including dirty ice) to that shore-based facility instead of discharging to surrounding waters if:

- *Its use is economically achievable, and*
- *The facility has a valid NPDES permit, or*
- *That facility discharges to an NPDES-permitted sewage treatment facility.*

Do not discard any unused live bait overboard, unless you caught that bait in that waterbody or watershed. Unused live bait purchased from a bait shop or dealer may not be discharged overboard unless the vessel operator has documentation from the dealer that the bait was caught in that waterbody.

AFFECTED VESSEL POPULATION

Based on the description of practices within this discharge category, only commercial fishing vessels have the potential to produce this discharge since no other vessels are expected to have fish holds. The vessel population potentially affected by practices applicable to discharges in the fish hold effluent category is shown in *Table 4-26.* Note that the vessel count presented in the table may overestimate the number of vessels to which the practice would apply since not all fishing vessels have fish holds.

Table 4-26. Vessel Counts for Fish Hold Effluent Practices

Vessel Class	Vessel Count
Commercial Fishing	2,326
Fishing Vessels	0
Freight Barges	0
Freight Ships	0
Passenger Vessels	0
Tank Barges	0
Tank Ships	0
Utility Vessels	0
TOTAL	**2,326**

COST ESTIMATES

The 2013 VGP requires that vessel operators use a physical separation method to remove excess large solid fish waste and residuals from the water prior to discharging fish hold effluent. Based upon EPA research, this practice is consistent with existing vessel practice: for example, vessels have coarse filters to keep large solid fish waste from being discharged with liquid effluent. *Codex Alimentarius* provides a recommended International Code of Practice for Fresh Fish, including technological guidelines for the handling and processing of fresh fish intended for human consumption (FAO, 1976). The Codex specifies that vessels should use coarse filters for their fish hold effluent. When present, these coarse filters should help ensure that no excess large solid fish debris is discharged, consistent with the VGP requirements.

EPA has also prohibited the discharge of fish hold effluent pierside where shore based facilities are available: where they are available, vessels must utilize these facilities if their use is economically achievable and the facility either has a NPDES permit or discharges to a NPDES-permitted sewage treatment facility.

According to a review of available information, at least two dockside facilities currently offer the option to discharge fish hold effluent to a shore-based facility instead of discharging to surrounding waters. These two facilities are in San Francisco, CA and Sitka, AK.

EPA assumes that there are no costs associated with not discarding any unused bait not sourced from the water body overboard, given that the vessel owners or operators can readily wait and discard the bait at an appropriate shore-based facility.

Therefore, none of the requirements described in this section are expected to represent an incremental cost to owners of commercial fishing vessels.

4.3 COSTS OF VESSEL-SPECIFIC REQUIREMENTS

Part 5 of the VGP stipulates additional requirements applicable to selected vessel classes. The cost implications of these requirements are discussed below, focusing on requirements revised in the 2013 VGP. Similar to the discussion of costs applicable across vessel types, the discussion follows the order of the sections in the VGP. For completeness, all sections are included, with notes on whether the VGP revisions are expected to represent incremental costs on vessel owners.

4.3.1 LARGE AND MEDIUM CRUISE SHIPS

PERMIT REQUIREMENTS

The 2013 VGP generally maintains the requirements specific to cruise ships contained in the 2008 VGP but makes minor clarifications (e.g., prohibition of discharges of toxic materials) and a few substantive changes to the requirements.

Revisions having the potential to impose incremental costs include those related to graywater discharges (i.e., treatment and monitoring), for which requirements applicable to large and medium cruise ships are more stringent than those applicable to other vessel types. Thus, cruise ship owners must monitor for additional parameters not previously included in the 2008 VGP: e. coli, total phosphorus, ammonia, nitrate/nitrite, and total kjeldahl nitrogen (TKN).

Other changes merely clarify the graywater requirements and are not expected to impose incremental costs on vessel owners. These include:

- Clarifications that requirements for initial monitoring of the graywater treatment system may be met through monitoring conducted under the 2008 VGP. This clarification removes potential duplicate monitoring.
- Clarifications that the schedule for submitting the annual monitoring report follows a calendar year schedule. This clarification does not affect the scope or frequency of reporting.
- Clarifications that the annual monitoring report is part of the NPDES annual reporting requirement. This separates the reporting requirement from reporting of the information to the COTP for cruise ships operating in Alaska waters.

Relevant excerpts of the permit text are included below.

Permit Text:

5.1 Large Cruise Ships (authorized to carry 500 people or more for hire

Discharge Standards:

Pierside Limits – While pierside, appropriate onshore reception facilities for graywater must be used unless the vessel treats graywater with a device to meet the standards in Part 5.1.1.1.2. If such facilities are not reasonably available and you do not have the capacity to treat graywater to meet the standards in Part 5.1.1.1.2, you must hold the graywater until the vessel is underway and not in waters subject to this permit. Appropriate reception facilities are those authorized for use by the port authority or local municipality and that treat the discharge in accordance with its NPDES permit.

Operational Limits: You must meet the following restrictions:

- *While operating within 3 nm from shore, discharges of graywater are prohibited unless they meet the effluent standards in Part 5.1.1.1.2.*

[Limits Applicable to Operation in Nutrient Impaired Waters (unchanged from 2008 VGP)]

[Graywater Treatment Standard (unchanged from 2008 VGP)]

Monitoring Requirements [Part 5.1.2]

Untreated Graywater [Part 5.1.2.1]

The discharge of untreated graywater by large cruise ships is not authorized in waters subject to this permit. Any discharge of untreated graywater within waters subject to this permit must be reported to EPA as an incidence of noncompliance on the vessel's Annual Report.

Treated Graywater [Part 5.1.2.2]

Prior to entering waters of the United States, vessel operators must demonstrate that they have an effective treatment system that complies with the standards in Part 5.1.1.1.2 if they will discharge graywater within 3 nm of shore.

Initial Monitoring [Part 5.1.2.2.1]

In order to demonstrate the effectiveness of the treatment system, the vessel operator must take at least five (5) samples from the vessel on different days over a 30-day period that are representative of the treated effluent to be discharged. A vessel owner/operator that submitted data to EPA for a vessel's discharge from an AWTS under the 2008 VGP requirements or has already received certification for continuous discharges from an AWTS and submitted data to the U.S. Coast Guard to meet the requirements of Section 1411(b) of Title XIV, Pub. L. 106-554 (Dec. 31, 2000, 114 Stat. 2763) [Certain Alaska Cruise Ship Operations] (codified at 33 USC 1901 note) does not need to conduct initial monitoring, and may instead immediately commence maintenance monitoring consistent with Part 5.1.2.2.2 of this permit.

Initial monitoring must be done within the first 90 days of permit coverage, within 90 days of AWTS installation onboard the vessel, or before vessels discharge into waters subject to this permit, whichever is later. Samples must be taken for BOD, fecal coliform, suspended solids, pH, and total residual chlorine. Furthermore, samples must be taken for E. coli, total phosphorus (TP), ammonia, nitrate/nitrite, and Total Kjeldahl Nitrogen (TKN). Sampling and testing shall be conducted according to 40 CFR Part 136. If the measured samples meet the standards specified in Part 5.1.1.1.2, then the owner/operator has demonstrated the effectiveness of their treatment system for controlling their graywater discharge. Records of the sampling and testing results must be retained onboard for a period of 3 years in the vessel's recordkeeping documentation.

Records of monitoring information shall include:

- *The date, exact place, and time of sampling or measurements;*
- *The individual(s) who performed the sampling or measurements;*
- *The date(s) analyses were performed;*
- *The individual(s) who performed the analyses;*
- *The analytical techniques or methods used; and*
- *The results of such analyses.*

Analytical results for total residual chlorine below the method detection limit shall be deemed compliant with the effluent limits, provided the permittee uses a testing method with a detection limit no higher than 10.0 µg/L under ideal conditions. EPA recommends Method SM4500-CL G (DPD Colorimetric Method) for these purposes as it is able to reach 10 µg/L under ideal conditions and so meets these requirements. SM4500-Cl G is typically the method that Alaska Department of Environmental Conservation (ADEC)/U.S. Coast Guard uses for compliance monitoring.

Testing and reporting for total residual chlorine is not required if chlorine is not used as disinfectant in the wastewater treatment works process and no water is drained to the graywater system from water with onboard chlorine additions (e.g., swimming pools, spas).

If a permittee has already received certification for continuous discharges from an AWTS by the U.S. Coast Guard to meet the requirements of Title XIV, Pub. L. 106-554 (Dec. 31, 2000, 114 Stat. 2763) [Certain Alaska Cruise Ship Operations] (codified at 33 USC 1901 note), the vessel need not conduct initial monitoring and may commence conducting maintenance monitoring.

<u>Maintenance Monitoring [Part 5.1.2.2.2]</u>

After demonstrating the effectiveness of their system, vessel owners/operators must collect and analyze one sample per quarter for each of the constituents listed in Part 5.1.2.2.1 to demonstrate treatment equipment maintenance and compliance with this permit for any quarter the vessel discharges graywater into waters subject to this permit. Furthermore, samples must be taken for E. coli, total phosphorus (TP), ammonia, nitrate/nitrite, and Total Kjeldahl Nitrogen (TKN). Regardless of whether a vessel has discharged into waters subject to this permit, maintenance monitoring must be conducted at least once per year or vessels must re-conduct initial monitoring in accordance with Part 5.1.2.2.1 before discharging into waters subject to this permit. Records of the sampling and testing results must be retained onboard for a period of 3 years in the vessel's recordkeeping documentation.

<u>Monitoring Reporting [Part 5.1.2.2.3]</u>

*The owner/operator must submit data showing that the graywater standards are achieved by their treatment system to EPA electronically or to EPA, ATTN: VGP Cruise Ship Monitoring Results, 1200 Pennsylvania Ave., MC 4203M, Washington, DC 20460 if they are eligible for a waiver under part 1.14 of this permit. Initial sampling data must be submitted at least 7 days before entering waters subject to this permit, within 90 days of obtaining permit coverage, or within 90 days of AWTS installation onboard the vessel, whichever is later. Maintenance monitoring data must be submitted at least once per calendar year no later than February 28 of the following year (e.g., 2014 data must be submitted by February 28, 2015). Data must be submitted on DMRs available in Appendix H and/or Appendix I of this permit or submitted to EPA electronically: the system is scheduled to be available at www.epa.gov/vessels/eNOI. Maintenance monitoring data may be submitted as part of the vessel's annual report (Appendix H)***.***

[…]

<u>5.2 Medium Cruise Ships (authorized to carry 100 to 499 people or more for hire)</u>

The requirements in Part 5.2 apply to vessel discharges from cruise ships providing overnight accommodations (i.e., cruise ships with onboard sleeping facilities) to passengers and authorized to carry between 100 and 499 people for hire.

5.2.1 Additional Effluent Limits

5.2.1.1 Graywater Management

All medium cruise ships must meet all requirements of this part, including the requirements of Parts 5.2.1.1.1, unless they are a vessel unable to voyage more than 1 nm from shore and were constructed before December 19, 2008. Medium cruise ships unable to voyage 1 nm from shore and constructed before December 19, 2008 must meet the requirements in Parts 5.2.1.1.3, 5.2.1.1.4, 5.2.1.1.5, 5.2.1.2, 5.2.2.1, 5.2.2.3, and 5.2.3.

5.2.1.1.1 Graywater Discharge Location and Rate

Pierside Limits – While pierside, appropriate onshore reception facilities for graywater must be used, unless the vessel treats graywater with a device to meet the standards in Part 5.2.1.1.2. If such facilities are not reasonably available and you do not have the capacity to treat graywater to meet the standards in Part 5.2.1.1.2, you must hold the graywater until the vessel is underway *and not in waters subject to this permit. Appropriate reception facilities are those authorized for use by the port authority or local municipality and that treat graywater in accordance with its NPDES permit.*

Operational Limits – You must meet the following restrictions: while operating within 3 nm from shore, discharges of graywater are prohibited unless they meet the effluent standards in Part 5.2.1.1.2.

Limits Applicable to Operation in Nutrient Impaired Waters – If you operate in nutrient-impaired waters including, but not limited to, the Chesapeake Bay or the territorial sea surrounding the mouth of the Mississippi River in the Gulf of Mexico, you must:

- *Not discharge any graywater in nutrient-impaired waters subject to this permit unless the length of voyage in that water exceeds the vessel's holding capacity for graywater; and*
- *Minimize the discharge of any graywater into nutrient-impaired waters subject to this permit, which may require minimizing the production of graywater; and*
- *If your vessel's holding capacity for graywater is exceeded, treat such excess graywater (above the vessel-holding capacity) by a device meeting the standards in Part 5.2.1.1.2 prior to discharge into nutrient-impaired waters subject to this permit; or*
- *Dispose of the graywater at an onshore facility which will discharge the effluent under a valid NPDES permit.*

A list of nutrient-impaired waters is available at www.epa.gov/npdes/vessels.

5.2.1.1.2 Graywater Treatment Standards

The discharge of treated graywater must meet the following standards:

1. The discharge must satisfy the minimum level of effluent quality specified in 40 CFR § 133.102;

2. The geometric mean of the samples from the discharge during any 30-day period may not exceed 20 fecal coliform/100 milliliters (ml) and not more than 10 percent of the samples exceed 40 fecal coliform/100 ml; and

3. Concentrations of total residual chlorine may not exceed 10.0 micrograms per liter (µg/l).

[…]

5.2.1.1.5 Graywater Discharge Location and Rate for Vessels Built before December 19, 2008 unable to voyage 1 nm from shore

While pierside, appropriate onshore reception facilities for graywater must be used if available and their use is economically achievable (unless the vessel treats graywater with a device to meet the standards in Part 5.2.1.1.2). Appropriate reception facilities are those authorized for use by the port authority or local municipality and that treat the discharge in accordance with its NPDES permit.

If such facilities are not available and you do not have the capacity to treat graywater to meet the standards in Part 5.2.1.1.2, you must hold the graywater unless the vessel is underway and sailing at a speed of at least 6 knots in a water that is not listed in Appendix G. When operating in nutrient impaired waters subject to this permit, you must not discharge any graywater into those waters subject unless the length of voyage in that water exceeds the vessel's holding capacity for graywater, and minimize the discharge of any graywater into nutrient-impaired waters subject to this permit, which may require minimizing the production of graywater.

[…]

5.2.2.2 Treated Graywater

Prior to entering waters of the United States, vessel operators must demonstrate that they have an effective treatment system that complies with the standards in Part 5.2.1.1.2 if they will discharge graywater within 1 nm of shore.

5.2.2.2.1 Initial Monitoring

In order to demonstrate the effectiveness of the treatment system, the vessel operator must take at least five (5) samples taken from the vessel on different days over a 30-day period that are representative of the treated effluent to be discharged. A vessel owner/operator that submitted data to EPA for a vessel's discharge from an AWTS under the 2008 VGP requirements or submitted such data to the U.S. Coast Guard to meet the requirements of Section 1411(b) of Title XIV, Pub. L. 106-554 (Dec. 31, 2000, 114 Stat. 2763) [Certain Alaska Cruise Ship Operations] (codified at 33 USC 1901 note) does not need to conduct initial monitoring, and may instead immediately commence maintenance monitoring consistent with Part 5.2.2.2.2 of this permit.

Initial monitoring must be done within the first 90 days of permit coverage, within 90 days of AWTS installation onboard the vessel, or before vessels discharge into waters subject to this permit, whichever is later. Samples must be taken for BOD, fecal coliform, suspended solids, pH, and total residual chlorine. Furthermore, samples must be taken for E. coli, TP, ammonia, nitrate/nitrite, and TKN. Sampling and testing shall be conducted according to 40 CFR Part 136. If the measured samples meet the standards specified in Part 5.2.1.1.2, then the owner/operator has demonstrated the effectiveness of their treatment system for controlling their graywater discharge. Records of the sampling and testing results must be retained onboard for a period of 3 years in the vessel's recordkeeping documentation.

Records of monitoring information shall include:

- *The date, exact place, and time of sampling or measurements;*
- *The individual(s) who performed the sampling or measurements;*
- *The date(s) analyses were performed;*
- *The individual(s) who performed the analyses;*
- *The analytical techniques or methods used; and*
- *The results of such analyses.*

Analytical results for total residual chlorine below the method detection limit shall be deemed compliant with the effluent limits, provided the permittee uses a testing method with a detection *limit no higher than 10.0 µg/L under ideal conditions. EPA recommends Method SM4500-CL G (DPD Colorimetric Method) for these purposes as it is able to reach 10 µg/L under ideal conditions and so meets these requirements. SM4500-Cl G is typically the method that ADEC/U.S. Coast Guard uses for compliance monitoring.*

Testing and reporting for total residual chlorine is not required if chlorine is not used as disinfectant in the wastewater treatment works process and no water is drained to the graywater system from water with onboard chlorine additions (e.g., swimming pools, spas).

5.2.2.2.2 Maintenance Monitoring

After demonstrating the effectiveness of their system, vessel owners/operators must collect and analyze one sample per quarter for each of the constituents listed in Part 5.2.2.2.1 to demonstrate treatment equipment maintenance and compliance with this permit. Records of the sampling and testing results must be retained onboard for a period of 3 years in the vessel's recordkeeping documentation.

5.2.2.2.3 Monitoring Reporting

The owner/operator must submit data showing that the graywater standards are achieved by their treatment system to EPA's e-reporting system or to EPA, ATTN: VGP Cruise Ship Monitoring Results, 1200 Pennsylvania Ave., MC 4203M, Washington, DC 20460. Initial sampling data must be submitted at least 7 days before entering waters subject to this permit, within 90 days of obtaining permit coverage, or within 90 days of AWTS installation onboard the vessel, whichever is later. Maintenance monitoring data must be submitted at least once per calendar year no later than February 28 of the following year (e.g., 2014 data must be submitted by February 28, 2015). Data must be submitted on DMRs available in Appendix H and/or Appendix I of this permit or submitted to EPA's e-reporting system available at www.epa.gov/vessels/eNOI, which will be available within two years of finalization of this permit. Data may be submitted as part of the vessel's Annual Report.

AFFECTED VESSEL POPULATION

The population estimate shown in *Table 4-27* was provided by Cruise Lines International Association (CLIA) in support to EPA's analysis of the 2008 VGP. Large sized cruise ships are in the 500+ passenger/crew capacity classification, and medium sized cruise ships are in the 100 to 499 passenger/crew capacity classification.[50]

[50] The estimated number of medium cruise ships in Table 4-27 was originally determined by EPA in its analysis of the 2008 VGP based upon a 250-499 passenger/crew capacity classification rather than the 100-499 range. However, based on data provided by CLIA, there are very few cruise ships within the 100-249 passenger/crew capacity classification. EPA therefore expected this estimate to be only slightly below the actual universe of medium cruise ships. NOIs submitted under the 2008 VGP confirm the universe of medium cruise ships with only 26 medium cruise ships seeking coverage under 2008 VGP through May 2012.

Table 4-27. Cruise Ship Counts.

Vessel Class[a]	Alaskan Certified Cruise Ships	Non-Alaskan Certified Cruise Ships	Total Count
Large Cruise Ships	30	113	143
Medium Cruise Ships[c]	0	32	32
TOTAL	30	145	[b] 175

a Cruise ships fall within the passenger vessels category.

b This count is based upon CLIA populations. There may be an additional 5 percent that are non-CLIA members.

c The estimated number of medium cruise ships was originally determined in the 2008 VGP analysis based upon a 250-499 passenger/crew capacity classification rather than the 100-499 range. At the time, preliminary data provided by CLIA indicated few cruise ships within the 100-249 passenger/crew capacity classification. NOIs submitted under the 2008 VGP have since confirmed the universe of medium cruise ships with only 26 medium cruise ships seeking coverage under 2008 VGP through May 2012. To be conservative, EPA retained the slightly larger count estimated in its analysis of the 2008 VGP when analyzing the 2013 VGP.

COST ESTIMATES

The majority of the practices associated with cruise ship graywater management are already implemented by the cruise ship industry. Changes to pierside and operational limits for large cruise ships would require vessels to treat their graywater to the specified standards, or hold graywater while pierside for later discharge beyond 3 nm from shore. Cruise ships already have the capacity to hold graywater for extended periods of time or are operating the necessary treatment systems to generate effluent that meets the limits specified in the 2013 VGP. Large cruise ships have the capacity to hold graywater for a minimum of 1 to 2 days, as evidenced by their ability to hold all wastewaters while sailing in areas such as Glacier Bay in Southeast Alaska, where discharges are generally prohibited under their concession contracts with the National Park Service. According to responses to EPA's 2004 cruise ship survey of large cruise ships operating in Alaskan waters, graywater holding capacity ranged from 5 to 90 hours, with an average holding capacity of 56 hours.

Requirements pertaining to operation in nutrient impaired waters, sculleries and galleys, hazardous waste, untreated graywater documentation, and monitoring have not changed substantively and therefore no incremental cost is associated with the 2013 VGP revisions.

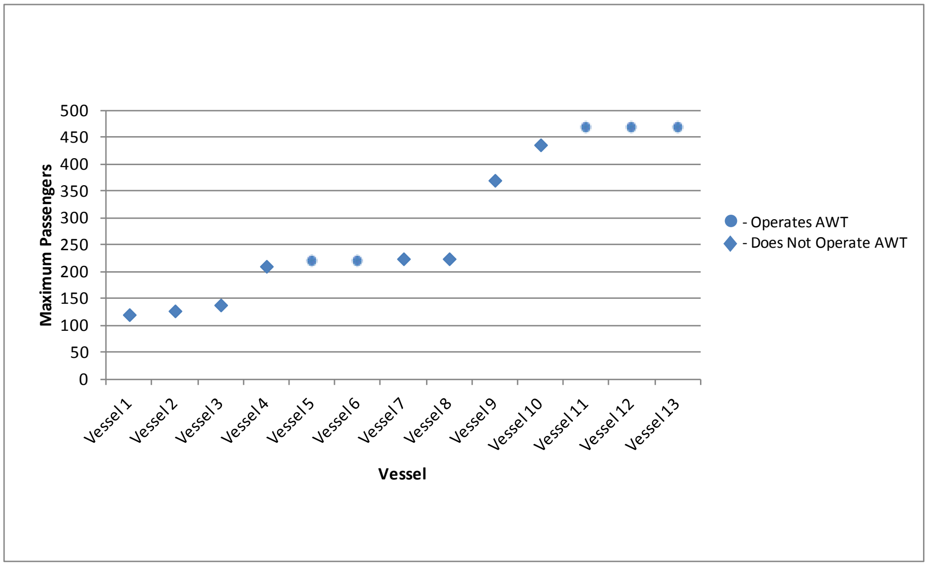
Requirements to include additional parameters as part of initial and maintenance monitoring are not expected to add a significant cost to owners of large cruise ships beyond the cost previously estimated as part of the 2008 VGP analysis (EPA, 2008a). This is because previously estimated costs for conducting the monitoring ($1,000 per event, in 2008 dollars) already represent a conservative estimate of the cost of collecting samples, performing the laboratory analyses, administering and keeping records, and covering all other incidentals associated with a monitoring event. The new parameters are not expected to add costs that would not already fit within this conservative estimate.

Medium cruise ships that treat their graywater and/or voyage more than 1 nm and discharge outside of water subject to this permit are already complying with graywater discharge standards. Vessels without graywater treatment systems and that do not voyage outside of 1 nm from shore or do not have the capacity to hold their graywater until they travel this far, may incur incremental costs if they need to install a graywater treatment system (and monitor their discharge). Note that the permit provides an exception from the graywater discharge location and rate requirements for those medium cruise ships unable to voyage more than 1 nm from shore and constructed before December 19, 2008. Hence, EPA does not expect all medium cruise ships covered by the 2008 VGP to have AWTs installed.

To assess the potential for incremental costs due to the need to install advanced wastewater treatment systems (AWTs) and monitor graywater discharge on medium cruise ships, EPA reviewed existing information in the docket for the proposed permit, including EPA's cruise ship analyses (EPA, 2008b) and a technical development document exploring treatment options for graywater (EPA, 2011).

Using this information and information in EPA's NOI database for the 2008 VGP, EPA conducted additional evaluation of the graywater management practices for U.S.-flagged vessels that identified "medium cruise ship" as their primary or secondary vessel type in their NOI submissions on the 2008 VGP. These included a total of 26 vessels. EPA eliminated from the evaluation 10 vessels that reported berthing (overnight accommodation) for zero passengers because these vessels would not meet the VGP definition of medium cruise ship (by that definition, a medium cruise ship provides overnight accommodations). Of the remaining 16 vessels, EPA determined that 5 vessels (31 percent) treat mixed graywater and sewage using AWTs identical in design and operation as those operated by large cruise ships that meet the graywater numeric effluent limits (e.g., ROCHEM Bio-Filt®, Hamworthy Membrane Bioreactor (MBR), and Scanship). EPA also identified two additional foreign flagged medium cruise ships operating these technologies. Of the remaining 9 vessels (69 percent), 8 vessels reported discharge of graywater without treatment, and 1 vessel reported treating mixed sewage and graywater using a traditional Type II marine sanitation device (MSD). See Sections 3.3 and 2.3.1 of EPA's Cruise Ship Discharge Assessment Report (EPA, 2008b) for a discussion of the characteristics of untreated graywater and of the performance of traditional MSDs, respectively. The AWTs operated by the five medium cruise ships in the NOI database include both new build and retrofit systems and were installed and operated on vessels carrying between 212 and 462 passengers (294 to 800 passengers and crew). Based on this information, there seems to be no clear distinction in the ability of medium cruise ships with different passenger capacities to implement AWT (see *Figure 1*).

Figure 1: Graywater Management Practices for U.S.-Flagged Medium Cruise Ships.



Three vessels did not report maximum passenger capacity on their NOI.

While EPA is not aware of any other smaller U.S.-flagged medium cruise ships that have installed AWTs, EPA contacted several AWT vendors of systems demonstrated to achieve the Part 5.1 and 5.2 discharge standards to discuss their system capabilities. Some vendors stated that their AWTs were too large to place on vessels other than large cruise ships, but two vendors stated that their AWTs are rated for use on vessels with fewer passengers and crew such as smaller-sized medium cruise ships. Specifically, one vendor stated that its Scanship system can treat mixed graywater and sewage for large cruise ship as well as vessels carrying as few as 100 passengers and crew. The ROCHEM Bio-Filt® vendor stated that their MBR is used to treat mixed graywater and sewage on all sizes of vessels, including large cruise ships as wells as vessels as small as mega yachts. Finally, while EPA did not contact the Hamworthy MBR vendor, their MBR reference list published on their website includes a system installed onboard a new build mega yacht with 120 passengers and crew. These contacts and additional information demonstrate that AWTs are available for use on smaller-sized medium cruise ships.

Additionally, EPA identified three type-approved AWTs designed for much lower hydraulic and organic loadings capacities (i.e., much fewer passengers and crew) than those operated onboard large cruise ships. One vendor states that their membrane bioreactor can be installed on vessels with as few as 25 crew/passengers for treatment of either mixed sewage and graywater or sewage only; a second vendor states that their biological treatment system with dissolved air flotation and UV disinfection can be installed on vessels with as few as 10 passengers and crew for treatment of either mixed sewage and graywater or sewage only; and a third vendor states that their biological treatment system with dissolved air flotation and UV disinfection can be installed on vessels with as few as 30 passengers and crew for treatment of mixed sewage and graywater. EPA notes that these systems can be installed onboard vessels *smaller* than the medium cruise ships in the size range of 100-249 passengers. EPA has not researched whether these three systems are scalable to the larger sizes that would be needed for medium cruise ships. However, as noted above, there are at least two AWTS technologies available on the market.

While AWTs used onboard medium cruise ships are identical in design and operation as those installed onboard large cruise ships, they are smaller in size and weight because they are scaled to treat the significantly lower volumes of graywater and sewage generated onboard medium cruise ships. For example, EPA compared the size (footprint) and wet weight of AWTs treating mixed sewage and graywater to traditional Type II marine sanitation devices (MSDs) treating sewage only. Specifically, EPA compared the Scanship AWP, sized to treat mixed sewage and graywater generated by 120 passengers and crew, to the Hamworthy ST-C Series Super Trident Sewage Treatment Unit, sized to treat sewage only from 169 passengers and crew (a traditional Type II MSD reported in the NOI database as used onboard one of the smaller-sized medium cruise ships). EPA found that the Scanship AWP was 1.3 times heavier and had a footprint 1.8 times larger on a per person basis than the traditional Type II MSD. For a vessel with 120 passengers and crew, the incremental weight is approximately 1,900 kg (the equivalent weight of 500 gallons of water—the amount of water used and subsequently the amount of sewage and graywater generated by fewer than 7 persons in a day[51]) and the incremental size is 40 ft^2 (a fraction of the size of a 200 to 600 ft^2 stateroom on a small-sized medium cruise ship). The ROCHEM Bio-Filt® vendor stated that their retrofit systems have a smaller footprint than biological Type II MSDs (such as the Hamworthy ST-C Series Super Trident Sewage Treatment Unit) and typically can be substituted for these systems. As an additional means of comparison, according to the NOI database, the ballast capacities of the smaller-sized medium cruise ships operated range between 9,437 and 20,689 gallons. This analysis, coupled with the demonstrated use and applicability of AWTs on vessels smaller than large cruise ships (including one with 120 passengers and one with 212 passengers), indicates that installation of AWTs would not have a significant effect on a small cruise ship's draft or stability and would not restrict access to desired cruise locations.

Hence, given that systems are available and in use today, that at least one permittee in this size class has installed a system to meet the numeric discharge graywater standards, and that AWTs systems are available for vessels even smaller than medium cruise ships (those in the 100-249 passenger category), EPA concludes that AWT systems suited to medium cruise ship operations are available for those vessels that need to treat their graywater when traveling within 1 nm from shore.

However, the Agency continues to believe that available vessel-specific data and information are insufficient to demonstrate the capability of all existing medium cruise ships to install retrofit AWTs if they were built before December 19, 2008. For example, the Alaska Department of Environmental Conservation commented that some cruise ships with fewer than 250 passengers have multiple graywater direct discharge ports, and that sometimes graywater is not mixed onboard. Retrofitting such systems to install AWTs may not be technically or economically feasible for an individual vessel operator if their vessel was built before December 19, 2008.

[51] US EPA, Cruise Ship Discharge Assessment Report, EPA-842-R-07-005, 2008.

Accordingly, EPA has exempted from graywater management requirements those medium cruise ships unable to voyage more than 1 nm from shore and constructed before December 19, 2008.

In the 2008 VGP, EPA had estimated that two vessels would need to install graywater treatment systems. In an effort to generate a conservative estimate, that some medium cruise ships may incur additional costs greater than EPA originally estimated, EPA is assuming that 0 to 2 additional medium cruise ships could need to treat their graywater within 1 nm.[52] The costs of installing the requisite AWTs are discussed in the next section.

SENSITIVITY ANALYSIS

The sensitivity analysis uses the following assumptions.

- *Graywater Treatment Costs:* The estimate of costs of installing, operating and maintaining a graywater treatment system is based upon EPA information gathered as part of its evaluation of standards for discharges of sewage and graywater from cruise ships operating in Alaska. Based upon these data, EPA estimated the average capital cost of installing a graywater treatment system at $1,468 per passenger (including crew), while the cost of operating and maintaining the graywater treatment system is $9.05 per capita and per season.[53] The average capital cost is annualized over 30 years using a 7 percent discount rate to derive an annual capital cost of $118.34 per passenger (including crew). Assuming an average number of 557 passengers and crew, the total cost (annualized capital plus O&M) per medium cruise ship is approximately $81,255 per year.
- *Sampling Costs:* Sampling and analysis cost estimates of treated graywater are based upon estimates presented in the 2008 VGP. The cost associated with one sampling event is estimated at $384 per ship. The actual cost of testing an individual sample, such as for biochemical oxygen demand (BOD), is low (approximately $50–$100); however, there are additional costs involved with the administration, setup, reporting, etc., of the actual sampling event. EPA assumed that each sampling event would require 4 hours of labor (at a rate of $33.72/hour). The sampling event accounts for the testing of each of the nine analytes (i.e., BOD, fecal coliform, suspended solids, pH, total residual chlorine, E. coli, TP, ammonia, nitrate/nitrite, and TKN). The cost of laboratory analyses is estimated at $249, including $30 in shipping and other incidental costs. The Permit specifications call for initial monitoring involving five sampling events over a 30-day period, followed by maintenance monitoring involving one sample per quarter. Thus, the first year will involve 8 sampling events and each subsequent year will involve 4 events each. Based upon the $384 average sampling cost ($249+4 x $33.72), EPA estimates the average

[52] These vessels are in addition to the 2 vessels EPA had estimated would need to install graywater treatment systems under the 2008 VGP since the 2008 VGP is considered the baseline for the analysis of the 2013 VGP.

[53] These costs were escalated to 2010 dollars from their original values in 2004 dollars of $1.050/capita and $7.09/capita using a construction cost index of 1.28 (183.5/143.7)

annual incremental cost per vessel at $1,493 for both initial and maintenance monitoring, where initial monitoring is annualized over the 5-years of the Permit.

- *Implementation Rate:* EPA assumed that medium cruise ships constructed after December 19, 2008 and those unable to travel farther than 1 nm from shore, or without the capacity to hold their graywater until they get there, would need to treat their graywater. EPA estimated that 0 to 2 medium cruise ships (low and high bound estimates, respectively) would need to install graywater treatment systems, beyond the 2 medium cruise ships already assumed to do so in the 2008 VGP analysis. EPA estimated incremental costs even though the requirements in the 2013 VGP are identical to those of the 2008 VGP.[54] This is assumed to be a conservative estimate given that vessels have the option to continue to hold their graywater until they can discharge. The cost per vessel for each practice and the total cost associated with all vessels are provided in *Table 4-28.* The total incremental costs range from approximately $83,200 to $166,300 per year.

Table 4-28. Cruise Ships Graywater Management Sensitivity Analysis.

Vessel Class	Total Number of Vessels	Incremental Vessels Implementing Graywater Management[a]	Annual Cost per Vessel	Total Annual Cost
Low End Estimate				
Graywater Treatment	32	0	$-	$0
Sampling and Monitoring	32	0	$-	$0
Low End TOTAL		**0**		**$0**
High End Estimate				
Graywater Treatment	32	2	$81,255	$162,511
Sampling and Monitoring	32	2	$1,911	$3,821
Total		2		
High End TOTAL				**$166,332**

a Incremental vessels based on the number of medium cruise ships unable to voyage 1 nm from shore and/or with insufficient graywater holding capacity.

4.3.2 LARGE FERRIES

The 2013 VGP generally retains vessel-specific requirements applicable to large ferries. One exception is the removal of requirements applicable to the discharge of coal ash from coal fired propulsion systems. Under the 2013 VGP, the discharge of coal ash slurry from coal fired propulsion systems from ferries is no longer authorized under the permit. This is consistent with

[54] EPA included the costs in response to comments the Agency received on the proposed 2013 VGP that suggested that EPA may have underestimated the number of cruise ships affected by this requirement under the 2008 VGP, in which case the incremental costs are relevant for the 2013 VGP.

EPA's suspension of the authorization for these discharges in December 2012. Based on comments submitted by the only known vessel owner/operator discharging coal ash into waters subject to this permit, that owner/operator had planned to eliminate this significant pollutant discharge within 3 years. Hence, either coal ash discharges must cease into waters subject to this permit or they must be authorized under an individual NPDES permit. The change in permit language is made to be consistent with the existing requirements and this revision therefore is not expected to impose incremental costs on large ferries.

4.3.3 UNMANNED BARGES (SUCH AS HOPPER BARGES, CHEMICAL BARGES, TANK BARGES, FUEL BARGES, CRANE BARGES, DRY BULK CARGO BARGES)

The 2013 VGP retains the vessel-specific requirements applicable to barges contained in the 2008 VGP with limited revisions to clarify the applicability of the requirements to unmanned barges and to barges used to transport petroleum and oil products. As these barges were originally included in the analysis of the 2008 VGP, the revisions are not expected to result in incremental costs. Other revisions include clarification on practices to prevent discharges of oily or toxic materials; the practices described in the revisions are already implemented by vessels and/or represent a negligible incremental cost on vessels that have the relevant equipment (scuppers).

Permit Text:

5.4.1 Additional Effluent Limits

Barges must minimize the contact of below deck condensation with oily or toxic materials and any materials containing hydrocarbon. Whenever barges are pumping water from below deck, the discharge shall not contain oil in quantities that may be harmful as defined in 40 CFR Part 110. If a visible sheen, as defined in Appendix A of this permit, is noted, vessel operators must initiate corrective action in accordance with Part 3 and meet recordkeeping requirements in Part 4.2 of this permit.

All tank barges must have spill rails and must mechanically plug their scuppers before any cargo operations if required by vessel class society and/or 33 CFR Parts 155 and/or 156. Additionally, scuppers, when available, must be mechanically plugged during fueling of ancillary equipment (e.g., generators and compressors) located on the deck of the barge. If scuppers are unavailable, other types of secondary containment should be employed. If any spills result during loading or unloading of cargo, or other ancillary equipment fueling operations, vessel owners/operators must completely clean up spills or residue before scuppers are unplugged.

Vessel owners/operators must clean out cargo residues (i.e., broom clean) such that any remaining residue is minimized before washing the cargo compartment or tank and discharging washwater overboard.

Vessel owners/operators must clean out cargo residues (i.e., broom clean) such that any remaining residue is minimized before washing the cargo compartment or tank and discharging washwater overboard.

5.4.2 Supplemental Inspection Requirements

After every instance of pumping water from areas below decks, or immediately following washing down the decks, you must conduct a visual sheen test. The visual sheen test is used to detect free *oil by observing the surface of the receiving water for the presence of an oily sheen. The operator should focus the inspection on the area surrounding the vessel where discharges from below deck or deck washings are discharges into the receiving water. A visible sheen is defined in Appendix A of this permit. If a visible sheen is observed, you must initiate corrective actions required in Part 3 of this permit and meet recordkeeping and notification (reporting) requirements in Part 4.2 of this permit.*

4.3.4 OIL TANKERS, PETROLEUM TANKERS OR BULK CHEMICAL CARRIERS

The 2013 VGP retains the vessel-specific requirements applicable to oil tankers, petroleum tankers, or bulk chemical carriers contained in the 2008 VGP with limited revisions to clarify the applicability of the requirements to bulk chemical carriers. As these vessels were originally included in the analysis of the 2008 VGP, the revisions are not expected to result in incremental costs.

4.3.5 RESEARCH VESSELS

The 2013 VGP vessel-specific requirements applicable to research vessels are identical to those contained in the 2008 VGP. No incremental cost is therefore anticipated.

4.3.6 EMERGENCY VESSELS (FIRE BOATS, POLICE BOATS)

The 2013 VGP vessel-specific requirements applicable to emergency vessels are identical to those contained in the 2008 VGP. No incremental cost is therefore anticipated.

4.4 GENERAL INSPECTION AND PERMIT PAPERWORK BURDEN

The 2013 VGP inspection and paperwork burden is associated with six types of activities:

- Recordkeeping;
- Notice of Intent filing;
- Routine inspections;
- Dry-dock inspections;
- Annual inspection; and
- Annual reporting

Some of the practices necessary to comply with these requirements are already implemented by vessel owners in accordance with business practices and to comply with the 2008 VGP requirements. However, commercial fishing vessels may incur incremental burden as a result of their coverage under the VGP. Additionally, for previously covered vessels, revisions to certain Permit requirements may change the costs associated with the relevant activities.

The 2013 VGP makes several modifications to the general inspection and paperwork requirements relative to the 2008 VGP. The revisions generally aim to clarify the requirements or reduce the burden on covered vessels by streamlining the process of submitting information to EPA, following comments EPA received from regulated entities. EPA also eliminated certain requirements present in the 2008 VGP. The principal revisions to permit requirements include:

- Permit revisions eliminate the one-time report previously required under the 2008 VGP.
- For recordkeeping, the revisions clarify that vessel owners may keep either paper or electronic records, provided that the format can be read in a similar manner as a paper record, is dependable, and is accessible during an inspection. This change improves the efficiency of recordkeeping.
- A new Permit Authorization and Record of Inspection (PARI) Form will need to be completed for vessels for which an NOI is not required. The short form (1 page) must be maintained onboard the vessel and used to document the conduct of annual inspections.
- For routine visual inspections, the 2013 VGP clarifies the frequency of inspections as once per week or per voyage and conducted on a schedule that coincides with other routine inspections, if feasible. The text changes do not modify the frequency of inspections required under the 2008 VGP. Other changes include removing the requirement to sample discharge streams otherwise not readily visually inspected on a quarterly basis.
- Changes to the requirements for vessels that are unmanned for an extended period of time (13 days or greater). The requirements specify the scope of the inspections and the frequency, both of which are meant to be less extensive than the regular routine visual inspection. This change may result in cost savings for owners of affected vessels.
- For annual reports, the revisions clarify the timing of the report according to calendar year with preference for electronic reporting. Additionally, for unmanned, unpowered barges and vessels less than 300 gross tons, the revisions allow owners to submit a single annual report for all their barges, provided that certain conditions are met (no analytical monitoring data are included, there were no instances of noncompliance, etc.). This change may result in cost savings for owners of affected vessels.

The implications of the revised permit requirements for currently covered vessels and of extending the scope of the permit to commercial fishing vessels are discussed below. Note that changes in the inspection and reporting burden associated with specific discharge categories (e.g., ballast water treatment systems, bilgewater treatment systems) are discussed within each discharge-specific section of this report, along with estimates for any associated incremental costs. For example, incremental burden due to BWTS monitoring, sampling, testing, and recordkeeping requirements is discussed in *Section 4.2.3* and the costs to conduct these activities are included in the costs for this discharge category.

4.4.1 REVISED PAPERWORK REQUIREMENTS

In analyzing the impacts of the 2008 VGP, EPA had developed high end estimates that assumed the time required for vessels for recordkeeping, routine inspections, drydock inspections, and annual inspections. The estimates varied from no additional time to additional time that varied according to the size of the vessels. This was based on the assumption that certain vessel classes are more likely to have a higher number of applicable discharge categories, and thus, a potentially higher number of practices to perform and report upon. EPA divided vessel classes according to two categories ("Large" and "Small"), where the categories reflect not only the average size of a vessel, but also its relative complexity. In determining inspection and recordkeeping burden, "large" vessels were assumed to have greater time requirement than "small" vessels. *Table 4-29* presents the crosswalk of vessel classes to the two categories.

Table 4-29. Vessel Class Breakdown.

"Large" Vessels	"Small" Vessels
	Commercial Fishing
Cruise Ships (Large or Medium)	Freight Barges
Freight Ships	Passenger Vessels (Other than Cruise Ships)
Tank Ships	Utility Vessels
	Tank Barges

Most of the revisions to the general inspection and paperwork requirements are not expected to result in significant incremental costs to vessel owners as they generally either clarify the requirements or recognize existing practices. For example, revisions to the routine inspection requirements do not change the expected frequency of such inspections, nor its scope; NOIs and annual reports are already being submitted electronically by the large majority of vessel owners. The addition of the PARI Form is assumed to represents minimal burden for vessels as the very short form (1 page) consists of information that is readily available to the owner and is used to document activities (annual inspections) that are already occurring under the baseline.

Nonetheless, some paperwork requirements will change in a material way and will result in additional burden for vessels already covered by the 2013 VGP, all else being equal. Also, commercial fishing vessels not previously covered by the 2008 VGP will incur new costs, relative to their existing recordkeeping and reporting practices. *Table 4-30* presents the inspection and recordkeeping burden assumptions for the 2013 VGP, by vessel category. Implications on two categories of vessels are discussed in the following sections: (1) vessels that were previously covered under the 2008 VGP, and (2) newly covered commercial fishing vessels.

Table 4-30. Assumptions of Burden Attributable to the 2013 VGP for General Inspection and Paperwork Requirements.

Requirement	Burden Hours for Small Vessels	Burden Hours for Large Vessels	Frequency
Recordkeeping	0.5	0.5	Annually
NOI	1.0	1.0	Once every 5 years
Routine inspections	1.5	2.5	Annually
Drydock inspection	2.0	4.0	Once every 5 years
One-time Report [a]	0.0	0.0	Once every 5 years
Annual Inspection	0.5	2.0	Annually
Annual Report [a]	1.0	1.0	Annually

Source: EPA, 2008, unless otherwise noted.

[a] The 2013 VGP eliminates the requirement for a one-time report. This report was estimated to take 0.5 hours in the 2008 VGP analysis.

[b] The annual report is a new requirement as of the 2013 VGP. This estimate does not include the lower unit burden of preparing combined reports for unmanned, unpowered barges and vessels less than 300 gross tons. It also excludes the overlap with separate non-compliance reports which would otherwise need to be submitted, if applicable to a given vessel.

4.4.2 CHANGES IN PAPERWORK REQUIREMENT BURDEN FOR VESSELS PREVIOUSLY COVERED UNDER THE 2008 VGP

EPA estimates that the requirement to submit an annual report will impose an incremental cost on vessel owners. Conversely, three revisions to the VGP requirements have the potential to reduce compliance costs for certain vessel owners in non-negligible ways: (1) the elimination of the one-time reporting requirement (a saving estimated at ½ hour for each vessel); (2) the submittal of combined annual reports for barges and vessels less than 300 gross tons, and (3) the reduced frequency of routine inspections for vessels that are unmanned for an extended period of time. The effects of these changes are discussed below.

As shown previously in *Table 4-30*, each annual report is estimated to take one hour to complete. At the labor rate of $33.72/hour, this is an incremental cost of $33.72/year per vessel. This requirement applies to all 58,602 vessels expected to seek coverage under the 2013 VGP. The elimination of the one-time reporting requirement mitigates this increase by reducing the burden for these same vessels by 0.5 hour per report. When amortized over the five years of the permit, this is a saving of $4.11/year per vessel.

The aggregate burden for annual reports will be less than one hour per vessel due to option available to some vessel owners to submit combined report. To estimate the effect of reducing the number of annual reports needing to be submitted for barges or vessels less than 300 gross tons, EPA used data on the average number of barges and vessels less than 300 gross tons operated by the same owner (see *Section 3.3*).

According to MISLE data, barge operators have, on average, 14 barges. Some operators, however, have significantly more barges under their name (up to a maximum of nearly 4,000) and 38 companies have more than 100 barges each. Savings associated with a single annual submittal for all barges may therefore be significant. Similar observations hold for vessels less than 300 gross tons although the aggregate reduction in burden may not be as dramatic. Operators of vessels less than 300 gross tons have, on average, 1.6 vessels, and up to a maximum of 83. Thirteen companies have more than 20 vessels each. Hence, although not as dramatic as for barges, savings associated with a single annual submittal for all vessels less than 300 gross tons can be significant.

Table 4-31 presents savings calculated across all barge and vessels less than 300 gross tons, based on MISLE data, assuming that companies with more than three barges and/or vessels less than 300 gross tons will submit a single annual report to EPA and that adding an additional barge or vessel to a combined report takes less time than preparing a single, separate report for that same barge or vessel. EPA assumed that each additional vessel added to a combined report takes ¼ of the time necessary for a single report (15 minutes) for combined reports with 3 to 9 vessels, and 5 minutes when submitting reports for more than 9 vessels. For example, preparing a report for 14 barges is assumed to take 60 minutes for the first barge plus 13 times 5 minutes for the 13 additional barges, or a total of 2.1 hours; EPA believes that the burden assumptions are conservative given likely similarities between vessels or barges operated by the same firm.

EPA estimated the changes in the number of reports that would be prepared given the assumptions above, along with the associated changes in burden hours and costs.

Table 4-31. Incremental Burden (Reduction) for Combined Annual Reports for Barges or Vessels less than 300 Gross Tons.

Scenario	Number of Individual Annual Reports Submitted	Total Annual Report Burden (hours)	Total Annual Report Costs[d]
Individual Reports (Baseline)[a]	53,337	53,337	$1,798,524
Combined Single Report Submitted[b]	4,528	13,692	$461,681
Change[c]	**(48,809)**	**(39,645)**	**($1,336,843)**

a Assumes that one report per barge or vessel is submitted to EPA.

b Companies with more than 3 barges or vessels less than 300 gross tons are assumed to submit a single combined report for all of their barges and vessels less than 300 gross tons.

c Negative value represents a reduction (saving) relative to baseline requirements.

d. Costs are estimated assuming 1 hour per baseline individual report. For combined report, each additional barge or vessel included in the report after the first one is assumed to require 15 minutes for combined reports having 3-9 vessels, and 5 minutes for reports more than 9 vessels. Costs associated with the burden hours are calculated using a labor rate of $33.72/hour.

Estimating the effects of the revised requirements for unmanned vessels is complicated by the lack of data on the number of vessels that are unmanned for extended periods of time. Reductions in the burden may be significant particularly in cases where the VGP requirements are the sole reason for conducting an inspection. Under the 2008 VGP, a vessel owner may be conducting a weekly inspection of the vessel with VGP-related recordkeeping representing only a small component of the inspection. Conducting routine inspections on a bi-weekly basis only while the vessel is unmanned for an extended period of time, for example during a six month period, reduces the annual burden associated with VGP compliance by 25 percent (for this particular example). The reduction in burden may be even larger, however, than suggested by the VGP burden alone, since the VGP burden is expressed as incremental burden beyond existing inspections and an owner may not need to perform a weekly inspection during this period other than to comply with the 2008 VGP routine inspection requirement.

Table 4-32 summarizes net incremental costs to vessels previously covered under the 2008 VGP. For the purpose of presenting results by vessel type, EPA distributed the estimated savings from preparing combined annual reports based on the distribution of barges and vessels less than 300 gross tons. As discussed above, the results do not include potential reductions in routine inspection burden for unmanned vessels.

Table 4-32. General Inspection and Paperwork Requirements for Vessels Covered under the 2008 VGP.

Vessel Class	Vessel Count	One-Time Report Adjustment (Annualized)	Annual Report	Combined Annual Report Adjustment	Total Annualized Cost
		Low and High End Estimates [a]			
Commercial Fishing [b]	142	$(584)	$4,789	$(2,808)	$1,396
Freight Barges	39,760	$(163,503)	$1,340,792	$(983,396)	$193,893
Freight Ships	812	$(3,338)	$27,375	$(3,444)	$20,593
Passenger Vessels	1,970	$(8,102)	$66,438	$(43,014)	$15,322
Tank Barges	7,144	$(29,379)	$240,915	$(176,698)	$34,839
Tank Ships	332	$(1,366)	$11,201	$(1,174)	$8,661
Utility Vessels	6,258	$(25,735)	$211,036	$(83,119)	$102,182
Low End TOTAL	**56,418**	**$(232,007)**	**$1,902,546**	**$(1,293,652)**	**$376,887**

[a] The same burden assumptions are used for the low and high end estimates.

[b] The count includes 142 commercial fishing vessels that submitted an NOI as of August 2010 and are covered under the 2008 VGP.

4.4.3 PAPERWORK REQUIREMENT BURDEN FOR NEWLY COVERED COMMERCIAL FISHING VESSELS

As shown previously in *Table 4-29*, commercial fishing vessels are assumed to have costs that are similar to those of other “small” vessels such as passenger vessels (except cruise ships), utility vessels, and barges.

Based on the burden assumptions presented in the previous section, and accounting for the proportionate share of savings derived from combined annual reports, the commercial fishing vessels newly covered under the 2013 VGP are estimated to incur incremental costs from general inspection and paperwork requirements of $253,149 for the high end estimate. Details of this estimate are shown in *Table 4-33*. For the low end estimate, the vessels are assumed to already implement all general inspection and recordkeeping practices as part of their existing business practices, except for the Permit-specific NOI submission and annual report and the total cost is estimated at $33,099.

Table 4-33. Incremental Burden Assumptions for General Inspection and Paperwork Requirements for Commercial Fishing Vessels not Covered by the 2008 VGP.

Requirement	Number of Vessels [a]	Cost per Vessel [b]	Total Costs
Recordkeeping [c]	2,184	$16.86	$36,825
NOI	321	$8.22	$2,640
Routine inspections [c]	2,184	$50.58	$110,475
Drydock inspection [c]	2,184	$16.45	$35,925
Annual inspection [c]	2,184	$16.86	$36,825
Annual report	2,184	$33.72	$73,650
Combined annual report adjustment			$(43,190)
Total (Low End Estimate)			**$33,099**
Total (High End Estimate)			**$253,149**

a The count excludes 142 commercial fishing vessels that submitted an NOI as of August 2010. The burden for these vessels is already included in the baseline for this rule.

b The costs are calculated assuming a labor rate of $33.72.

c Cost is excluded from low end estimate

4.5 ANALYSIS OF TOTAL NATIONAL COSTS

The estimated total compliance costs for each of the practices that have the potential to represent an incremental cost to vessel owners are provided in *Table 4-34.* The estimated VGP compliance costs vary between the low and high end estimates because of the different assumptions made regarding the vessel populations and the number of instances for which incremental costs will be incurred. As shown in the table, the largest share of incremental costs is associated with practices related to the oil-to-sea interface discharge category, followed by those in the ballast water and graywater discharge categories. Various changes to streamline the paperwork requirements for certain types of vessels are expected to result in an aggregate reduction in inspection and recordkeeping burden and associated costs.

Table 4-34. Total Annual Compliance Costs, by Practice Category and Vessel Class

	Total Annual Costs (2010$)								
Vessel Class	Deck Washdown	Bilgewater	Ballast Water	Cathodic Protection	Oil to Sea Interfaces	Graywater	Exhaust Gas Scrubber Washwater	Medium Cruise Ships (Graywater)	General Inspection and Paperwork
Low End Estimate									
Commercial Fishing	$0	$2,352	$28,637	$0	$535,944	$26,207	$0	$0	$34,496
Freight Barges	$0	$2,205	$0	$0	$1,821,277	$0	$0	$0	$193,893
Freight Ships	$0	$2,793	$221,566	$0	$531,425	$12,777	$2,981	$0	$20,593
Passenger Vessels	$0	$1,911	$79,042	$0	$483,788	$48,297	$0	$0	$15,322
Tank Barges	$0	$4,409	$0	$0	$327,697	$0	$0	$0	$34,839
Tank Ships	$0	$1,176	$37,136	$0	$101,011	$5,146	$1,220	$0	$8,661
Utility Vessels	$0	$15,139	$300,688	$0	$2,181,334	$23,145	$0	$0	$102,182
Low End Total	**$0**	**$29,983**	**$667,068**	**$0**	**$5,982,476**	**$115,572**	**$4,201**	**$0**	**$409,986**
High End Estimate									
Commercial Fishing	$141,627	$5,135	$61,512	$144,496	$1,643,424	$45,787	$0	$0	$254,545
Freight Barges	$0	$2,407	$0	$0	$5,607,112	$0	$0	$0	$193,893
Freight Ships	$0	$6,098	$463,653	$0	$1,613,887	$16,166	$32,167	$0	$20,593
Passenger Vessels	$0	$4,172	$165,105	$0	$1,483,738	$51,611	$0	$166,332	$15,322
Tank Barges	$0	$4,814	$0	$0	$1,007,955	$0	$0	$0	$34,839
Tank Ships	$0	$2,567	$1,988,674	$0	$306,639	$6,527	$13,161	$0	$8,661
Utility Vessels	$0	$33,056	$642,197	$0	$6,651,332	$38,884	$0	$0	$102,182
High End Total	**$141,627**	**$58,249**	**$3,321,142**	**$144,496**	**$18,314,088**	**$158,974**	**$45,328**	**$166,332**	**$630,036**

Table 4-35 summarizes the total estimated costs to each vessel class across the discharge categories. As shown in the table, total annual costs range between \$7.2 million and \$23.0 million, depending on the set of assumptions used.

Table 4-35. Total Annual Compliance Costs for All Practices, by Vessel Type, Including Paperwork Costs.

Vessel Type	Total Cost (2010\$)[a]
Low End Estimate	
Commercial Fishing	\$627,635
Freight Barges	\$2,017,375
Freight Ships	\$792,134
Passenger Vessels	\$628,360
Tank Barges	\$366,946
Tank Ships	\$154,349
Utility Vessels	\$2,622,487
Low End Total	**\$7,209,287**
High End Estimate	
Commercial Fishing	\$2,296,526
Freight Barges	\$5,803,413
Freight Ships	\$2,152,564
Passenger Vessels	\$1,886,281
Tank Barges	\$1,047,608
Tank Ships	\$2,326,230
Utility Vessels	\$7,467,651
High End Total	**\$22,980,271**

[a] Only includes U.S. flagged vessels.

4.6 UNCERTAINTIES AND LIMITATIONS

There is significant uncertainty in several assumptions that affect the costs discussed in this section, including:

- The number of vessels expected to implement practices to comply with new requirements is uncertain. In addition to uncertainty regarding the number of vessels operating in U.S. waters (see *Section 2.6*), there is also uncertainty regarding practices currently implemented by active vessels. For practices that are included in (or were considered for) the 2008 VGP for at least some vessels, EPA used information obtained from industry representatives during the development of the 2008 VGP. The information reflected conditions before promulgation of the VGP and therefore may differ from baseline practices currently being implemented. EPA also relied on information compiled from NOIs received through May 8, 2012. The NOI information is self-reported and not always consistently reported across all vessels. Nonetheless, the NOI data likely provide the most relevant indicator of practices implemented by the subset of NOI vessels for the analysis baseline. To account for uncertainty in the number of vessels that implement practices, EPA used ranges wherever possible to indicate the sensitivity of the results to varying assumptions.

- Cost information was obtained from industry during the development of the 2008 VGP. EPA complemented this information with additional research of public data and personal communications with industry experts. For example, the costs of bilgewater treatment systems were developed by reviewing manufacturer specification, published literature, and through interviews with industry representatives. Costs for laboratory tests, soaps and cleaners, and other practice components were obtained using similar sources. Because EPA made a limited number of contacts, the relevant estimates are likely to be subject to uncertainty regarding their applicability to different vessels considering the diversity of vessel characteristics and operations. Additionally, these costs are generally applicable to major ports in the coterminous United States. Costs may be higher in more isolated ports or regions of the country (e.g., costs in Alaska may be significant higher than in the lower-48). Wherever possible, EPA used ranges to reflect the diversity in costs in different regions.
- For certain practices – most notably the use of environmentally acceptable lubricants – EPA was unable to obtain detailed information on either product costs or quantities likely to be purchased for different types of vessels, despite numerous attempts to obtain the information from various industry representatives including from lubricant manufacturers, vessel owners, or ship maintenance companies. Industry representatives we contacted could not provide the requested cost information either because they considered the data confidential business information, because they did not feel that their data were sufficiently representative, or because they felt that any estimate they may be able to develop would not appropriately capture variability across vessels or locations. The anecdotal information EPA was able to obtain regarding EAL prices or volumes were not sufficiently detailed to be used in the analysis. For the purpose of this preliminary analysis, EPA relied on pricing information obtained from retail vendors and on an illustrative example provided by one industry representative. The assumed prices for conventional and EALs may be higher or lower than prices actually paid by vessel owners for different products and vessel types. EPA estimated quantities of lubricants for different vessel classes based on leakage rates reported for different types of vessels in Edkin (2010). The amount of lubricant purchased by vessel owners would have to be at least enough to make up for leaks and leakage rates may therefore represent a lower bound for the amount of lubricant purchased. Anecdotal information EPA compiled from industry representatives suggests, however, that these volumes are generally within the range of annual consumption of lubricants used in oil-to-sea interfaces for different classes of vessels.
- There is uncertainty about the number of vessels to which some practices apply, either because of a lack of detailed information about individual vessels or because of evolving technologies that may change the character of vessel discharges. Requirements applicable to discharges from exhaust gas cleaning systems (EGCS) apply to a subset of vessels that use such systems (see *Section 4.2.26*). A present, only a handful of vessels use EGCS and projections on the number of domestic vessels that may be equipped with EGCS in the

future are highly speculative. To reflect the uncertainty, EPA used ranging assumptions on the number of vessels to which the different requirements may apply.

Given these important areas of uncertainty, the cost estimates discussed throughout this report should be interpreted as illustrative of the range of incremental costs that may result from complying with the revised VGP requirements, and not as a precise account of costs that a vessel owner may incur for any specific vessel.

5 ANALYSIS OF IMPACTS ON FIRM REVENUES AND FINANCIAL PERFORMANCE

The previous chapters assessed total compliance costs to vessels of revisions to the VGO requirements. As summarized in *Section 3*, most of these vessels are associated with firms in the fishing and water transportation industries. *Section 4* presents the ranges of incremental costs that may be incurred by each vessel covered by the VGP, depending on the assumed unit costs of each required practice, which may vary by vessel type, size, and operating characteristics.

To determine the economic impacts of revisions to the VGP, EPA examined the incremental compliance costs relative to the financial conditions of "typical" businesses associated with the affected vessels. Since over 95 percent of the firms in the water transportation and fishing industries and in the drilling oil and gas wells sector are small (see *Section 3.4.3),* it is unlikely that a significant number of large firms would incur material impacts. Large firms are also more likely to operate larger or a greater number of vessels. Because the relative impact of VGP compliance and the number of affected entities are expected to be much greater for small entities, [55] the firm-level analysis focuses on assessing impacts on small businesses,.

5.1 METHODOLOGY

The analysis involves combining the estimated incremental operating costs attributed to compliance with the 2013 VGP with information about baseline financial conditions of model firms in each industry to examine the potential financial impacts on firms. Cost-to-revenue ratios are used as metrics for potential financial stress, where financial stress may reveal itself as a lack of profitability, cash deficiencies, or even bankruptcy. Firms expected to experience financial stress may need to change their business operations, including potentially downsizing or closing operations.

The key steps of the analysis involve: (1) assigning each vessel in the vessel database to a NAICS code, (2) estimating the number of vessels per firm in each industry, (3) estimating the distribution of compliance costs per vessel and per firm, and (4) comparing the costs to the firm revenues. These steps are described below.

5.1.1 ASSIGN EACH VESSEL TO A NAICS CODE

The framework for the model firms reflects the range of firm types across the major industry groups. Financial data for each major industry groups are available in the Economic Census while SBA provides firm data by revenue bracket. Since the Economic Census does not have the same

[55] Small entities are defined as one of the following: A small business according to SBA size standards; a small governmental jurisdiction that is a government of a city, county, town, school district, or special district with a population of less than 50,000; or a small organization that is a not-for-profit enterprise that is independently owned and operated and is not dominant in its field.

vessel categories as compared to other data sources (notably the MISLE/WTLUS database, which contains more complete numbers of all potentially regulated vessels and firms), each of the vessels and firms from the vessel database was assigned to a NAICS code to correspond to the Economic Census industry categories. The number of firms likely to incur costs as a result of the Permit was identified using the MISLE/WTLUS data based on the number of uniquely named managing owners for vessels expected to be covered by the VGP. Firms identified in the vessel databases were assigned a NAICS code in order to determine the number of firms subject to permit requirements for each NAICS code. Industry classification information for individual firms listed in the vessel databases was obtained primarily from ReferenceUSA's Business Database (ReferenceUSA, 2006), Dun & Bradstreet's Million Dollar Database (Dun & Bradstreet, 2006) and *manta.com*, supplemented by company Web sites and industry publications. Both ReferenceUSA and Dun & Bradstreet link subsidiaries and branch offices to company headquarters, allowing for an identification of domestic parent entities. Dun & Bradstreet's Million Dollar Database classifies businesses based on eight-digit Standard Industrial Classification (SIC) codes. Since both the Census and SBA categorize their data using NAICS codes, EPA matched the first four digits of the SIC codes provided in Dun & Bradstreet to corresponding six-digit NAICS codes using the U.S. Census Bureau's bridge between 1987 SIC and 2002 NAICS codes (U.S. Census Bureau, 2002b), and then mapped these codes directly to 2007 NAICS codes (2007 NAICS codes for the affected industries are unchanged from their 2002 definitions). The Dun & Bradstreet company names were matched to the vessel owner/operator names in the MISLE/WTLUS database to provide a NAICS code classification for most vessels in the vessel database. Vessels that could not be matched to a NAICS code based on their owner/operator were allocated to the NAICS sectors using the relative distribution of vessels across the sectors, by vessel type.

After estimating the number of firms with vessel permits for each NAICS code, EPA distributed these firms across revenue size categories proportionally to the distribution of firms by revenue size category indicated in Economic Census data. This estimated distribution of firms by revenue size category is assumed to be more accurate than estimates that could be derived solely from the Economic Census, since the Economic Census includes firms that are not expected to be affected by the rule. EPA used these totals to determine the number and percentage of firms experiencing economic impacts.

5.1.2 ESTIMATE THE NUMBER OF VESSELS PER FIRM

To establish the baseline and post-cost financials for each model firm, EPA applied the per-vessel practice costs developed in *Section 4* to the firm level. To determine the total incremental costs that a firm could incur, EPA first estimated the average number of vessels owned and operated by firms in each NAICS sector using information from the combined MISLE/WTLUS database.

As shown in *Table 5-1*, the average number of vessels varies across the NAICS sectors from about one vessel per owner in the fishing industry, to nearly four vessels per owner in the support activities for water transportation sector. These statistics represent the numbers of vessels operated by firms in each industry after excluding outlier firms that operate thousands of barges. Thus, of over 6,000 unique operators associated with vessels subject to the VGP, only 39 firms operate more than 100 vessels; the Department of Transportation is the only identified organization with more than 100 non-barge vessels. See *Section 5.3: Uncertainties and Limitations* for a discussion of impacts on firms with a larger number of vessels than indicated in *Table 5-1*.

Table 5-1: Number of Vessels by Firm in Each Industry Sector.

NAICS Description	Number of Vessels[a] Listed Under the Same Managing Owner: Minimum	Maximum	Average
Water Transportation Industry			
Deep Sea, Coastal, and Great Lakes Water Transportation	1	32	1.8
Inland Water Transportation	1	72	2.0
Scenic and Sightseeing Transportation, Water	1	24	1.3
Support Activities for Water Transportation	1	74	3.7
Fishing Industry			
Fishing	1	96	1.1
Mining Industry			
Drilling oil & gas wells sector	1	34	3.1

Source: EPA analysis of MISLE data (USCG, 2009).

[a] *Excludes barges. For barges, the number of vessels listed under the same managing owner ranges between 1 and 4,066, with an average of 13.9 barge per owner.*

For each NAICS code, EPA determined the number of vessels that were listed with a firm name as well as the number of firms corresponding to these vessels. Based upon the total number of firms and vessels within the subset in each NAICS code, the average number of vessels per firm was determined for each NAICS code. However, since this value is expected to vary among the different firm sizes, this average value was adjusted for each revenue size category so that the average number of vessels in each revenue size range is proportional to the midpoint of revenue in a revenue size category and the total number of vessels obtained when multiplying the number of firms by the number of vessel is equal to the total vessel population. After reallocating the vessels according to the revenue categories, NAICS sectors may have up to 1,300 vessels (for inland water transportation (NAICS 483211), most of which are barges) for the largest firms in the industry.

EPA expects that some firms, particularly those in the smallest revenue category (annual revenue less than $100,000), may not operate vessels subject to the 2013 VGP. For example, they may use vessels less than 79 feet, which are not covered by the VGP. This is consistent with reported revenue per vessel discussed in *Section 3.4.2*, which indicate revenue for per vessel that is often greater than the average revenue of firms in the smallest revenue category (approximately $50,000). For example, revenue of commercial fishing firms using medium and large vessels ranged between $82,000 and nearly $2.5 million, with average revenue to Northeast fishermen using vessels 75 feet and over averaging $790,779 per vessel in 2010 (NOAA, 2011b). Historical data of per vessel revenue for other industry sectors suggest earnings in the $10,000 to $40,000 per day (USCG, 2012a). While these figures represent averages for certain types of vessels and operations and variability is expected, they nonetheless suggest that larger vessels such as those covered by the VGP are less likely to be operated by firms in the lowest revenue category.

Accordingly, EPA allowed the average number of vessels for firms in the lowest revenue category to be less than one (0.5 vessels per firm), reflecting the fact that not all of the smallest of firms operate vessels subject to the 2013 VGP and/or the vessels they operate tend to be at the lower end of the size range and have lower compliance costs (e.g., do not employ onboard ballast water treatment, consume less lubricants, require less complex inspections).

5.1.3 ESTIMATE THE DISTRIBUTION OF COSTS PER VESSEL

For each vessel type and discharge category, EPA has already estimated in *Section 4:* (1) the total number of vessels, (2) the probability of a vessel incurring incremental costs, and (3) the incremental cost of each practice. By assuming that the probability of incurring an incremental cost for a given practice is independent of incurring costs for any of the other practices, EPA can estimate the probabilities of incurring costs for all possible combinations of practices.

In the analysis, the low end cost estimate includes up to thirteen possible practices, and the high end cost estimate includes up to fifteen possible practices. [56, 57] Treating each practice cost as an independent, binary "on/off" cost event, this means that there are theoretically 2^{13} and 2^{15} possible combinations of cost events for the low end and high end cost estimate, respectively. Each combination cost event is defined on the basis of whether or not each of the specific practices is "on" or "off" (and the resulting costs) together with the probability of each practice being "on" or "off." Each practice is assigned a probability of occurrence for each vessel class by dividing the number of vessels estimated to incur a given practice cost by the total number of vessels, and therefore this is the probability for the individual practice to be "on." Conversely, the probability of the individual practice being "off," is equal to one *minus* the probability of the practice occurrence. The overall probability of occurrence for a given practice combination is the product of these individual probabilities. As a result, most of the cost combinations are not meaningful for the impact analysis because one or more of the practice "on/off" instances in the combination event have a zero probability of occurrence, and thus the overall probability of that particular event, which is calculated as the product of the individual "on" or "off" practice probabilities, is zero. The high occurrence of zero probability *combination* practice events results from the presence of practice costs that are always assumed to be incurred, or have one hundred percent probability of occurrence. The maximum number of observed practice combinations for a vessel type is therefore smaller than the theoretical 32,768 possibilities ($32,768 = 2^{15}$).

For each of the possible practice combinations, EPA multiplied the total number of vessels by vessel class by the calculated probability of the combination practice event to estimate the

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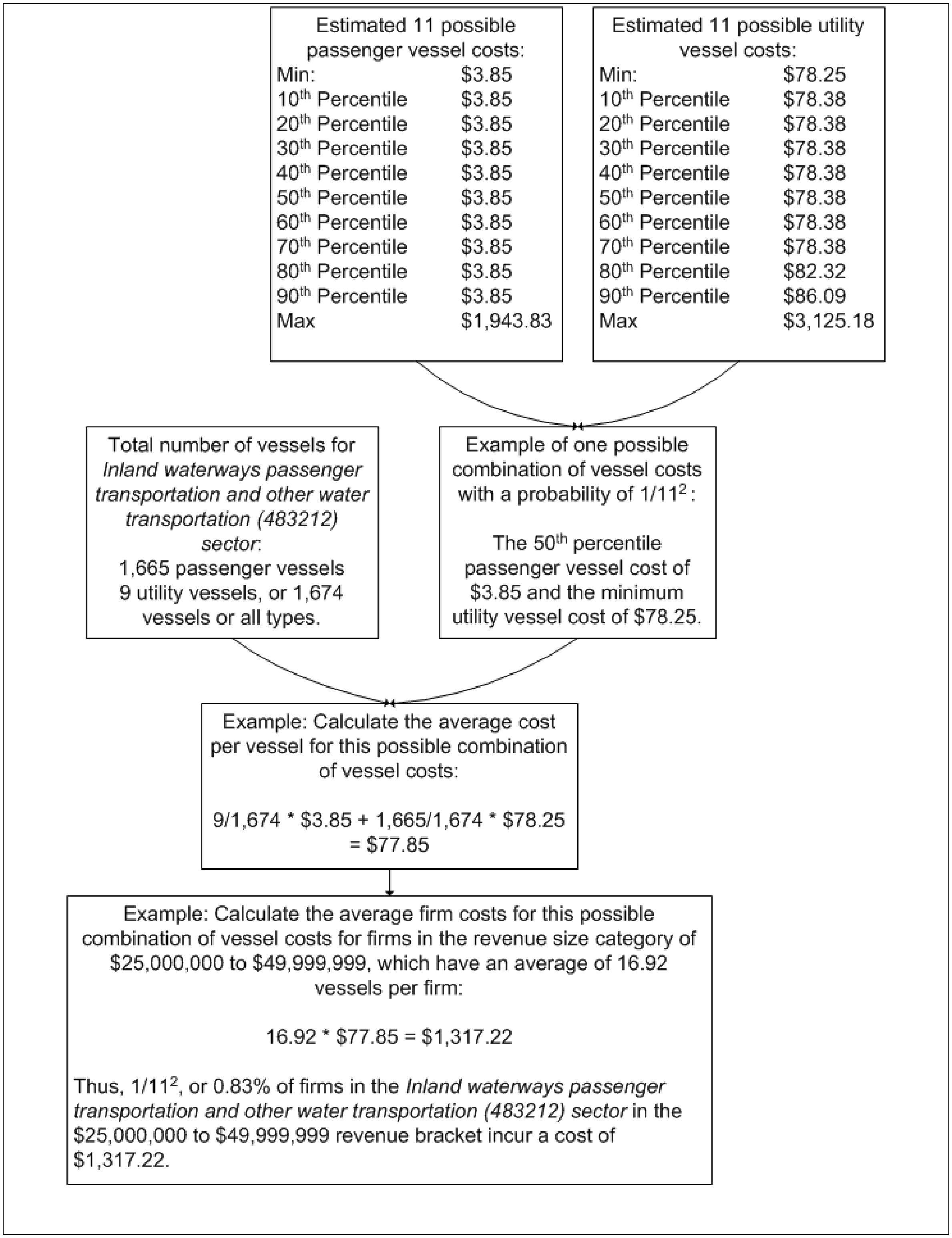
[56] The possible low end cost practices include: deck cleanup; drip pans and drip pan cleaning; ballast water treatment; ballast water monitoring; ballast water biological testing; ballast water biocide testing; bilgewater monitoring; oil-to-sea interfaces; graywater; medium cruise ship; NOI; annual report; and exhaust gas scrubber.

[57] The possible high end cost practices include the thirteen low end practices plus cathodic protection (for commercial fishing vessels not previously covered by the 2008 VGP) and ballast water treatment (for tankers engaged in coastwise trade exclusively).

number of vessels incurring costs for a given combination of practices. Finally, EPA calculated the per-vessel cost by vessel class associated with each combination of practices by summing the costs of the individual practices where costs are incurred. This calculation provided the distribution of per-vessel costs. The distribution shows a high probability of occurrence for low cost combination practice events. The probability of occurrence declines rapidly as the cost of the combination practice events increases. The higher cost combination practice events—which require a combination of all or nearly all of the individual practices—have a low probability of occurrence.

EPA estimated the distribution of per-firm costs from the distribution of per-vessel costs using the following approach. For firms in industries with more than one vessel class, EPA estimated vessel costs corresponding to the minimum, maximum and each 10 percentile increment in between these extremes – thereby yielding 11 possible vessel costs, which are assumed to be equally likely. For firms in industries with two vessel types, EPA evaluated the firm costs for 11^2 possible combinations of costs. For firms in industries with N vessel types, EPA evaluated the firm costs for 11^N possible combinations of costs – 11 possible costs for each vessel class. For each industry, EPA calculated an average per-vessel cost from the vessel class-specific costs for all 11^N possible combinations based on the relative number of vessels in each class. This average cost per vessel was then multiplied by the number of vessels per firm in each industry for a given revenue size category. Thus, for industries with more than one vessel class, EPA estimated a distribution of costs per firm with 11^N equally likely possibilities, where N is the number of vessel classes observed for the industry. There were three sectors with only one vessel class, four sectors with four vessel classes, and two sectors each with two, and five vessel classes. *Figure 2* illustrates the calculation of firm cost impact for one possible combination of vessel costs and one revenue size bracket in a sector with two vessel classes.

Figure 2: Illustrative calculation potential firm cost for one sector with two vessel types.



5.1.4 COMPARE FIRM-LEVEL COSTS TO FIRM-LEVEL REVENUES

EPA used data from the Economic Census as well as from the SBA's Statistics of U.S. Businesses to characterize the firm-level financial data for the transportation and mining industries. These sources provided the distribution of firms across several revenue brackets as well as the average revenue value in each revenue bracket. For firms associated with commercial fishing vessels, we combined Census information with statistics from NOAA and other sources on revenue per vessel (see *Section 3.4*) to characterize the distribution of revenue among firms of different sizes.

To evaluate the potential impact of the revised VGP on small entities, EPA used a cost-to-revenue test to evaluate the potential severity of economic impact on vessels and facilities owned by small entities. The test calculates annualized pre-tax compliance cost as a percentage of total revenues and uses a threshold of 1 and 3 percent to identify facilities that could be significantly impacted as a result of this Permit.

The cost values equivalent to the 1 and 3 percent thresholds were estimated from the average revenue in each revenue bracket, or the midpoint of the revenue bracket when average revenue was not reported. EPA estimated the percentage of firms that could be significantly impacted as a result of the VGP revisions as the percentage of firm for which the estimated firm-level costs (number of vessels times the per vessel compliance costs) exceeded the 1 percent or 3 percent revenue thresholds.

5.2 SMALL ENTITY ANALYSIS

As described, EPA prepared an analysis that examines the impacts of this Permit on small entities. A small entity may be:

- A small business according to SBA size standards;
- A small governmental jurisdiction that is a government of a city, county, town, school district, or special district with a population of less than 50,000; or
- A small organization that is a not-for-profit enterprise that is independently owned and operated and is not dominant in its field.

The SBA defines small businesses based on NAICS codes and size standards expressed by the number of employees or annual receipts (13 CFR §121.20). For the water transportation, fishing, and drilling oil and gas wells sectors, SBA's business size standards are based on annual revenues as well as employee size. The thresholds are as follows (U.S. SBA, 2010):[58]

[58] Based on SBA definitions in effect at the time EPA conducted its analyses.

- Deep sea, coastal, and Great Lakes water transportation; inland water transportation – fewer than 500 employees
- Scenic and sightseeing transportation; navigational services to shipping and salvage; other support activities for water transportation – revenues less than $7 million
- Port and harbor operations; marine cargo handling – revenues less than $25.5 million
- Fishing – revenues less than $4 million
- Drilling oil and gas wells sector – fewer than 500 employees.

If the revenues or employment were smaller than the corresponding thresholds, EPA classified the entities as small. *Section 3.4.3* presents the number of small businesses in each sector of the water transportation and fishing industries, and of the drilling oil and gas wells sector within the mining industry. On the whole, the affected industries consist of more than 90 percent small businesses. Based on data from the U.S. Census Bureau and the SBA, of the 4,603 firms in the water transportation industries, 4,365 (95 percent) are small. In the fishing industry, 1,973 (96 percent) of the 2,053 firms are small. In the drilling oil and gas wells sector, 2,073 (98 percent) of the 2,109 firms are small.

After calculating the distribution of per-firm costs, the number and percentage of firms where costs exceed 1 percent and 3 percent of revenue was estimated (by NAICS sector and revenue bracket).

The costs used in this economic analysis are annualized costs, which reflect the annual equivalent value of first-year (one-time) costs and recurring costs. The resulting 2010 annualized costs for implementing practices to address relevant discharges range from $0 to about $86,317 per vessel, with the upper value for a cruise ship assumed to incur the maximum of each applicable practice cost. Maximum compliance costs vary depending on the vessel type. For example, the maximum annual cost for a barge assumed to incur the maximum of each and every applicable practice is about $600, with most of this cost associated with bilgewater practices. The maximum annualized cost for a tank ship, $68,200, corresponds to a vessel engaged in coastwise trade exclusively, that installs and operates a BWTS, and incurs the maximum costs for all other VGP practices. Across all vessel categories, relatively few vessels incur the maximum compliance costs and average annual costs are significantly lower: between $51 and $7,023, depending on the vessel type.

After calculating the distribution of per-firm costs, the number of firms where costs exceed 1 percent and 3 percent of revenue was estimated (by NAICS sector and revenue bracket). The costs used in the economic analysis are annualized costs, which reflect the annual equivalent value of first-year (one-time) costs and recurring costs.

Table 5-2 summarizes the average firm-level revenue, number of firms, and cost thresholds across industry sectors for the 1 percent and 3 percent cost-to-revenue tests. The cost thresholds indicate the compliance costs that would correspond to 1 percent and 3 percent of revenue, and yield a significant impact based on the cost-to-revenue test. Because the impact of VGP compliance is likely to be most significant for firms at the lower end of the firm size spectrum, the table focuses on firms in the smallest revenue category in each industry. This category includes firms earning less than $100,000 each year in 2007 (in 2007 dollars).

As shown in the table, compliance cost thresholds range between $442 and $1,739 per year for the 1 percent and 3 percent levels, respectively, depending on the industry, for firms in this smallest revenue category. Note that firms categorized as "small" may have annual revenue significantly higher than $100,000.

Table 5-2. Estimated 1% and 3% Revenue Thresholds by NAICS Code for Firms in Smallest Revenue Category.

NAICS	Industry	Average Revenue of Firms in Category (2010$)[a,b]	Number of Firms in Revenue Category[b]	Compliance Cost at 1% Revenue Threshold (2010$)	Compliance Cost at 3% Revenue Threshold (2010$)
Water Transportation					
483111	Deep sea freight transportation	$48,072	21	$481	$1,442
483112	Deep sea passenger transportation	$57,521	15	$575	$1,726
483113	Coastal/Great Lakes freight transportation	$50,316	33	$503	$1,509
483114	Coastal/Great Lakes passenger transportation	$56,359	22	$564	$1,691
483211	Inland waterways freight transportation and towing transportation	$54,334	32	$543	$1,630
483212	Inland waterways passenger transportation and other water transportation	$54,127	42	$541	$1,624
487210	Scenic and sightseeing transportation, water	$53,970	526	$540	$1,619
488310	Port and harbor operations	$44,191	18	$442	$1,326
488320	Marine cargo handling	$54,334	25	$543	$1,630
488330	Navigational services to shipping and salvage	$56,305	97	$563	$1,689
488390	Other support activities for water transportation	$57,965	126	$580	$1,739
Fishing					
1141	Commercial fishing	$57,680	505	$577	$1,730
Mining					
213111	Drilling oil and gas wells	$52,504	237	$525	$1,575
213112	Support activities for oil and gas operations	$50,954	826	$510	$1,529

[a] Category includes all firms with receipts less than $100,000 in 2007. Average revenue restated in 2010 dollars by multiplying by GDP deflator (1.09)

[b] Source: SBA: U.S. All Industry Data by Receipt Size: 2007.

Table 5-3 presents the distribution of the entities' cost-to-revenue ratios. As summarized in *Table 5-3*, the model results suggest that the total number of entities in the *fishing industry* that are expected to exceed the one percent cost-to-revenue threshold ranges between 0 and 94 for the low end and high end cost assumptions, respectively.[59] If we assume that all these entities are small, the higher number represents about 5 percent of small firms. The total number of entities in the *water transportation industry* that are expected to exceed the one percent cost-to-revenue threshold ranges from 76 to 246 under the low and high end cost assumptions, respectively, representing approximately 6 percent of small firms, if we assume that all affected entities are small firms.[60] Overall, slightly less than 6 percent of firms have costs estimated to exceed the one percent cost-to-revenue threshold and less than 1 percent of firms are estimated to exceed the three percent cost-to-revenue threshold, based on high end cost estimates.[61]

The critical cost thresholds range depending on revenue range and NAICS code. For example, a firm in the commercial fishing industry within the revenue range of $0-$100,000 (with average revenue for firms within the bracket of $57,680) would have a one percent critical cost threshold of $577. On the other hand, a firm within the marine cargo handling industry within the revenue range of $100 million or more (with average revenue of over $235 million) would have a one percent critical cost threshold of nearly $2.4 million. The majority of firms in the water transportation and fishing industries have revenue ranging between $100,000 and $499,999.

As shown in *Table 5-3,* the percentage of firms expected to exceed the 1 percent threshold under both the low and high end cost assumptions ranges from 0 to 23 percent depending on the NAICS code and industry level (4-digit NAICS vs. 6-digit NAICS). In examining the percentage of entities affected, the entities with the largest estimated impacts are in the *Deep sea, coastal, and Great Lakes water transportation* and *Support activities for water transportation* sectors, where up to 11 percent of small entities, assuming that all affected entities are small, exceed the 1 percent threshold under the high end cost assumptions; however, these industries have very few entities (13 each, which is no more than 2 percent of small entities, assuming all affected entities are small) estimated to exceed the 3 percent threshold. Under the low end cost assumption, only 5 entities exceed the 3 percent threshold in all sectors combined.

As discussed later in *Section 5.3*, there is uncertainty in the estimated impacts of the revised VGP requirements on small entities, due to the way costs are allocated to vessels and to firms. In the absence of more detailed information on the characteristics of vessels and their respective owning firms, the analysis is meant to illustrate the potential magnitude of impacts to firms of different sizes. To the extent that small firms own a large number of vessels subject to the 2013 VGP

[59] The distributional analysis model is likely overstates impacts to firms in this sector due methodology limitations discussed later in this Section and in Section 5.3, notably EPA's conservative assumptions regarding the distribution of vessels to firms across size categories and relatively uniform characteristics of vessels assigned to firms with very different annual revenue.

[60] Idem.

[61] Idem.

and/or own vessels with inordinately high incremental costs, the analysis may understate the impacts of VGP compliance on these firms. As discussed in the uncertainty section at the end of this Chapter, however, EPA looked at selected examples of firms that operate a large number of vessels and for which the Agency was able to obtain firm-level revenue from D&B; EPA found that incremental costs were well below 1 percent of revenue. Considering per vessel revenue described earlier in this section and in *Section 3.4.2*, however, EPA believes that the analysis generally tends to overstate, rather than understate, compliance costs.

Table 5-3. Results of the Small Entity Impact Analysis.

NAICS Code	NAICS Description	1 Percent of greater			Between 1 and 3 Percent			3 Percent or greater		
		# Firms	% All Firms	% Small Firms	# Firms	% All Firms	% Small Firms	# Firms	% All Firms	% Small Firms
	Low End Cost Estimate									
11411	Finfishing, shellfishing, and other commercial fishing	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
1141	**TOTAL Fishing**	**0**	**0.0%**	**0.0%**	**0**	**0.0%**	**0.0%**	**0**	**0.0%**	**0.0%**
483111/483113	Deep sea/coastal and Great Lakes freight	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
483112/483114	Deep sea/coastal and Great Lakes passenger	18	10.9%	11.1%	13	8.0%	8.2%	5	2.9%	3.0%
4831	**TOTAL Deep sea, coastal, and Great Lakes water transportation**	**18**	**2.6%**	**2.6%**	**13**	**1.9%**	**1.9%**	**5**	**0.7%**	**0.7%**
483211	Inland waterways freight transportation and towing transportation	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
483212	Inland waterways passenger transportation and other water transportation	6	3.4%	3.4%	6	3.4%	3.4%	0	0.0%	0.0%
4832	**TOTAL Inland water transportation**	**6**	**1.3%**	**1.4%**	**6**	**1.3%**	**1.4%**	**0**	**0.0%**	**0.0%**
487210	Scenic and sightseeing transportation, water	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
4872	**TOTAL Scenic and sightseeing transportation**	**0**	**0.0%**	**0.0%**	**0**	**0.0%**	**0.0%**	**0**	**0.0%**	**0.0%**
488310	Port and harbor operations	15	7.8%	8.9%	15	7.8%	8.9%	0	0.0%	0.0%
488320	Marine cargo handling	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
488330	Navigational services to shipping and salvage	37	5.7%	6.7%	37	5.7%	6.7%	0	0.0%	0.0%
488390	Other support activities for water transportation	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
4883	**TOTAL Support activities for water transportation**	**52**	**3.0%**	**3.4%**	**52**	**3.0%**	**3.4%**	**0**	**0.0%**	**0.0%**
	TOTAL WATER TRANSPORTATION	**76**	**1.9%**	**2.1%**	**71**	**1.8%**	**1.9%**	**5**	**0.1%**	**0.1%**
	TOTAL	**76**	**1.3%**	**1.4%**	**71**	**1.2%**	**1.3%**	**5**	**0.1%**	**0.1%**
	High End Cost Estimate									
11411	Finfishing, shellfishing, and other commercial fishing	94	4.6%	4.8%	94	4.6%	4.8%	0	0.0%	0.0%
1141	**TOTAL Fishing**	**94**	**4.6%**	**4.8%**	**94**	**4.6%**	**4.8%**	**0**	**0.0%**	**0.0%**
483111/483113	Deep sea/coastal and Great Lakes freight	38	7.1%	7.3%	32	6.0%	6.1%	6	1.2%	1.2%
483112/483114	Deep sea/coastal and Great Lakes passenger	24	14.6%	15.0%	17	10.3%	10.5%	7	4.3%	4.4%
4831	**TOTAL Deep sea, coastal, and Great Lakes water transportation**	**62**	**8.9%**	**9.1%**	**49**	**7.0%**	**7.2%**	**13**	**1.9%**	**2.0%**
483211	Inland waterways freight transportation and towing transportation	5	2.0%	2.1%	5	2.0%	2.1%	0	0.0%	0.0%
483212	Inland waterways passenger transportation and other water transportation	17	9.8%	9.8%	14	8.0%	8.0%	3	1.8%	1.8%

NAICS Code	NAICS Description	1 Percent of greater			Between 1 and 3 Percent			3 Percent or greater		
		# Firms	% All Firms	% Small Firms	# Firms	% All Firms	% Small Firms	# Firms	% All Firms	% Small Firms
4832	**TOTAL Inland water transportation**	**23**	**5.1%**	**5.2%**	**20**	**4.4%**	**4.5%**	**3**	**0.7%**	**0.7%**
487210	Scenic and sightseeing transportation, water	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
4872	**TOTAL Scenic and sightseeing transportation**	**0**	**0.0%**	**0.0%**	**0**	**0.0%**	**0.0%**	**0**	**0.0%**	**0.0%**
488310	Port and harbor operations	30	15.0%	17.2%	29	14.5%	16.6%	1	0.5%	0.6%
488320	Marine cargo handling	4	1.5%	1.8%	4	1.5%	1.8%	0	0.0%	0.0%
488330	Navigational services to shipping and salvage	127	19.9%	23.4%	115	18.0%	21.2%	12	1.9%	2.2%
488390	Other support activities for water transportation	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
4883	**TOTAL Support activities for water transportation**	**161**	**9.3%**	**10.7%**	**148**	**8.6%**	**9.8%**	**13**	**0.8%**	**0.9%**
	TOTAL WATER TRANSPORTATION	**246**	**6.3%**	**6.8%**	**216**	**5.5%**	**5.9%**	**30**	**0.8%**	**0.8%**
	TOTAL	**340**	**5.7%**	**6.1%**	**310**	**5.2%**	**5.5%**	**30**	**0.5%**	**0.5%**

Figures do not necessarily add to totals due to rounding.

5.3 UNCERTAINTIES AND LIMITATIONS

In addition to uncertainty previously discussed in *Section 4.6* relating to the compliance cost estimates for the various discharge categories, the distributional analysis discussed in this section involves additional uncertainties related to how these costs are allocated to firms in each industry sector.

For example, there is uncertainty surrounding the assignment of vessels to firms of different sizes. The VGP applies to non-recreational and non-military vessels 79 feet or more in length only. Vessel and firm-level data are not sufficiently detailed, however, to assign vessels of different sizes to firms in different revenue categories. Yet, the results of the distributional analysis are sensitive to this assumption. For the purpose of this analysis, EPA assumed that firms in the smallest revenue category potentially own and operate vessels covered by the VGP, and, further, that these firms are as likely as larger firms to own and operate any of the vessels covered by the VGP, regardless of its size or complexity. Instead, firms in the smallest revenue category possibly own and operate smaller vessels not covered by the VGP but instead covered separately under the sVGP. These firms would incur no incremental costs due to the revised VGP requirements. Even in cases where small firms own vessels covered by the VGP, these vessels may be smaller and less complex than the vessels owned by larger firms. As was discussed in *Section 3.4.2*, per vessel revenue generally increases with vessel size, suggesting that firms with lower revenue generally operate smaller vessels. Because of this distribution and because compliance costs tend to increase with vessel size and complexity, the analysis may overstate impacts on small firms. EPA adjusted the distribution to account for this to some degree by allowing firms in the smallest of the revenue categories (firms with annual revenue less than $100,000) to be assigned costs for less than one VGP vessel.

In conducting the distributional analysis, EPA did not include cost savings associated with streamlining of the inspection, recordkeeping, and paperwork requirements. This is due to the difficulty of assigning these cost savings to any specific vessel since the savings will depend on the number of vessels owned by any given firm. As discussed in *Section 4.4*, however, these cost savings could be significant for firms with multiple freight or tank barges or with unmanned vessels.

For each revenue bracket, EPA assumed that firm revenues were equal to the average revenue in the bracket (or the midpoint when the average was not available). There is uncertainty associated with this simplifying assumption, because calculating an average firm cost results in less variation compared to an alternative approach that simulates a distribution of firm revenues within revenue size ranges.

There is uncertainty surrounding EPA's assumption that the average number of vessels per firm is proportional to the midpoint of the revenue bracket. These assumptions may result in underestimation or overestimation of the number of vessels per firm, and the underestimation or overestimation may vary by revenue size category. In general, EPA believes that it is reasonable to assume that the smaller firms are likely to own or operate fewer vessels, or may own or operate a vessel that is smaller than the VGP size threshold of 79 feet. EPA received comments in response to its proposed VGP noting that some firms operate a much larger number of vessels (barges) than the maximum assumed by EPA in its analysis. Based on information contained in MISLE/WTLUS, this is true primarily of freight and tank barges, with some firms operating hundreds or even thousands of barges (e.g., Ingram Barge Company has nearly 4,000 barges in MISLE/WTLUS; Canal Barge Company has over 500 barges). While compliance costs for barges are generally relatively low given the subset of applicable discharge categories, the aggregate costs of the VGP could be significant when multiplied by a large number of vessels. Compliance costs for the two firms provided as examples above are $586,600 and $73,300, respectively, using an average annual cost of $146 per barge. This represents less than 0.3 percent of the sales reported by D&B for either of the two firms in 2007.

There is uncertainty surrounding the choice of using only 11 possible costs for each vessel class (minimum, maximum, and by 10 percentile increments) and more accurate estimates could be obtained by using a greater number of cost possibilities. However, since industries can have up to seven vessel types, the number of sampled vessel costs is limited by computational feasibility - with up to 6 possible vessel-class costs and 7 vessel types there are 6^7 possible firm costs.

After simulating a sample of vessel class costs, EPA calculated an average cost per vessel across all vessel classes within each industry sector. For example, NAICS 483212 include both passenger vessels and utility vessels, and on average, firms in the lowest revenue bracket have one vessel. Since 98 percent of the firms' vessels are passenger vessels, the firm cost is estimated as the weighted average of vessel costs (0.98 * [Passenger Vessel Cost] + 0.02 * [Utility Vessel Cost]). There is uncertainty associated with this simplifying assumption, because calculating a weighted average vessel cost results in less cost variation compared to an alternative approach that simulates a distribution of vessel classes for firms.

Finally, there is uncertainty associated with the simplifying modeling assumption that practices are cost events with independent probabilities of being assigned to any one vessel. Instead, EPA expects that larger vessels are more likely to incur costs for more of the applicable practices, i.e., a vessel that is large enough to use a BWTS to comply with the ballast water requirements could also be more likely to employ bilgewater treatment.

6 BENEFITS ANALYSIS

EPA expects that reductions in vessel discharges resulting from revisions to the VGP will benefit society in two broad categories: (1) reduced risk of invasive species introduction and (2) enhanced environmental quality from reduced pollutant discharges. *Section 6.1: Ballast Water and Invasive Species Impacts* provides a qualitative assessment of the ecological and economic impacts of invasive species introductions and the benefits of reducing the occurrence of invasive species. *Section 6.2: Benefits of Reduced Pollutant Discharges from Vessels* discusses pollutants of concern (POCs) found in vessel discharges, their environmental effects, and the benefits likely to be achieved by the revised VGP requirements.

6.1 BALLAST WATER AND INVASIVE SPECIES IMPACTS

6.1.1 INTRODUCTION AND BACKGROUND

Introductions of non-indigenous species have occurred in the United States for centuries, with more than 50,000 total non-native species thought to be successfully established with reproducing populations in U.S. territory (Pimentel et al., 2005). Scientists and governments have long recognized the economic and ecological damages associated with land-based invaders, but attention has only turned toward aquatic non-indigenous species (ANS) since the 1980s, when the extent of the zebra mussel invasions in the Great Lakes region first became a serious problem (Ruiz and Reid, 2007). ANS invasions have caused tremendous economic and ecological damages to critical coastal and inland waters throughout the United States.

ANS may be introduced through a variety of vectors, including intentional introductions, escape from a confined environment, or ballast water and sediment from ballast tanks. One of the major known vectors for ANS introduction is through the ballast water tanks of commercial vessels. Ballast water is taken on in or near port to provide stability to ships that are not fully loaded. Often, aquatic invertebrates, plants, or microorganisms, as well as suspended sediments that may contain invasive species, are unintentionally taken in along with the ballast water.

Studies conducted by NOAA's Great Lakes Environmental Research Laboratory (GLERL) found that a majority of ships and a near-majority of tanks surveyed contained non-indigenous strains of pathogens known to cause human health impacts (Johengen et al., 2005; Reid et al., 2007). The Johengen et al. (2005) study also found that viable populations of non-native dinoflagellate and invertebrate species were present in a large majority of tanks sampled. Glassner-Shwayder (1999) refers to ships with ballast water as "biological islands" because they carry such a wide variety of organisms in their ballasts. According to some studies, as many as 4,000 species can be found in a typical ship's untreated ballast water at one time.

When this ballast water is discharged in another port, or when sediments in the ballast tank are mixed with new ballast water, these species can be introduced into an exotic environment, and may become established under some conditions (Ruiz and Reid, 2007). Several of the most harmful invasive species currently known to exist in the United States, including the zebra mussel, the green crab, and the Asian clam, are all thought to have been introduced via ballast water. Researchers hypothesize that as international trade, and therefore shipping traffic, increases, so does the threat of more ANS introductions (Glassner-Shwayder, 1999).

The U.S. Coast Guard's 2004 Rulemaking for Mandatory Ballast Water Management (codified in 33 CFR 151) mandated open ocean ballast water exchange for ships traveling outside the 200-nautical mile exclusive economic zone (EEZ) of the United States. While promulgation of the USCG regulation is reducing the probability of new introductions, it covers neither vessels traveling within the U.S. EEZ nor vessels with empty ballast tanks, both of which are potential sources of ANS introductions. The ballast water provisions of EPA's 2008 VGP aimed to address these gaps where possible, further reducing the possibility of ANS introductions. Specifically, the 2008 VGP required ballast water exchanges at least 50 nm from shore for vessels engaged in Pacific nearshore voyages, which were previously exempted from mandatory exchange procedures. It also required saltwater flushing for vessels declaring no ballast on board (NoBOB) or for vessels with some proportion of their ballast tanks empty. Several states have promulgated regulations that complement or strengthen national ballast water management requirements specified in the 2008 VGP.

While useful in reducing the presence of potentially invasive organisms in ballast water, ballast water exchange and saltwater flushing have variable effectiveness and may not always be feasible due to vessel safety concerns (EPA SAB, 2011). On March 23, 2012, the U.S. Coast Guard finalized new ballast water management standards to revise rules at 33 CFR 151 (77 FR 17254) and specify limits on the discharge of living organisms that are similar to IMO's Regulation D-2.[62] EPA incorporated the USCG Standards/IMO D-2 requirements in its revised Permit. The 2013 VGP also includes monitoring, sampling, testing, and reporting requirements to verify the efficacy of ballast water treatment systems used onboard vessels. Stricter limits on ballast water discharges and the confirmatory monitoring and testing will contribute to reducing the risk of ANS invasions and their consequences.

6.1.2 ANS IMPACTS

ANS invasions are a persistent problem in U.S. coastal and inland waters. ANS invade U.S. waters through a number of dispersal mechanisms including releases from fisheries; research and education facilities; restoration efforts; public aquaria and the aquarium pet industry; and by being attached to or within ships, drydocks, amphibious planes, floating marine debris, drilling platforms, navigation buoys and marine floats, canals, and recreational equipment (Carlton et al., 2003). Each vector has been associated with introductions of highly damaging species in the past, although this analysis will focus primarily on the ballast vector described in the previous section.

[62] If practicability review shows that it is feasible, this Phase One standard would be followed by a "Phase Two" standard that set concentration limits at 1,000 times more stringent than Phase One standards for viable organisms greater than 10 microns and for bacteria and viruses.

Though no reliable and comprehensive estimates of total ANS introductions nationwide exist, case studies of several major bodies of water across the country, as summarized in *Table 6-1,* provide a sense of the extent of the problem.

Table 6-1: Estimates of Invasive Species in Several Major Water Systems.

Region	Estimated Rate of Invasion[a]	Estimated Total Invasions to Date[b]
Great Lakes	Once every 28 weeks[c]	162
Mississippi River System	Unknown	100
San Francisco Bay	Once every 24 weeks[d]	212
Lower Columbia River Basin	Once every 5 months[e]	81
Gulf of Mexico	Unknown	579

a Ruiz and Reid (2007) suggest that these figures may not reliably represent the true rate of introduction, as they are based on discovery data, which may not always track with the underlying rate of introduction.

b All figures in this column are taken from USCG (2004b).

c NOAA (2007).

d Cohen and Carlton (1995).

e Sytsma et al. (2004).

The total costs associated with ANS in the United States are staggering. In the Regulatory Analysis of its ballast water standards, the U.S. Coast Guard estimates the avoided damages from preventing future initial invasions over a 10-year period at $6 to $518 millions of dollars annually, at a 3 percent discount, depending on the assumed effectiveness of the standards and control costs per species (USCG, 2012a). However, EPA believes these estimates to be highly conservative, and considering that the benefits are cumulative beyond ten years, they are likely to be far higher over an average vessel's service life. A 2005 study suggests that expenditures on control alone for ANS in the United States total approximately $9 billion annually (Pimentel et al., 2005). A broad range of damages are associated with any introduction of a given type of species, summarized in *Table 6-2.* Although some species cause no economic damage, others may cause hundreds of millions of dollars in damages. The majority of these damages may be broken down into six broad categories of impacts, which are described in the subsequent subsections.

Table 6-2: Estimates of Invasive Species Damages by Type of Species.

Type of Species	Range of Potential Damages per Invasion per Year (Million 2010$)
Fish	0 – 161[a]
Mollusks	0 – 6,415[b]
Non-Mollusk Invertebrates	0 – 23.8[c]
Plants	0 – 36.9[d]
Pathogens	0 – 0.764[e]

a Based on Ruffe (Leigh, 1998), adjusted to 2007$ using CPI.

b Based on Zebra Mussel (Pimentel et al., 1999), adjusted to 2007$ using CPI.

c Based on European Green Crab (EPA, 2008a).

d Based on hydrilla (OTA, 1993), adjusted to 2007$ using CPI.

e Based on an outbreak of epidemic cholera (Lovell and Drake, 2007), adjusted to 2007$ using CPI.

COMMERCIAL AND RECREATIONAL FISHERIES

As noted above, the introduction of ANS can cause the imbalance of native ecosystems. ANS pose an especially serious risk to commercial and recreational fisheries, which like other aquatic resources could be devastated by ANS (IDNR, 2003). Several examples of ANS impacts on fisheries are provided below (reported dollars are for the publication year).

- ***Sea Lamprey:*** The sea lamprey, which is native to the Atlantic Ocean, was not initially introduced to the Great Lakes by ballast water, but has been introduced elsewhere through contaminated ballast water (Toledo, 2001). Upon its initial introduction, the sea lamprey caused a massive collapse of the trout fisheries in the Great Lakes. If sea lamprey control measures were eliminated, the resulting lost value to fisheries would be approximately $500 million annually, according to one estimate (OTA, 1993). Control measures that have been introduced to counteract the impacts of sea lampreys cost more than $12 million annually (ANSTF, 2007).

- ***European Green Crab:*** The most likely mode of the initial European green crab introduction on the East Coast of North America was ship fouling (Cohen et al., 1995). Other possible pathways of introduction include ballast water and solid ballast. Grosholz (2006) and Cohen (1997) believe that incidental transport with commercial fishery products is the most likely vector for the initial introduction of C. maenas to the West Coast. The annual estimated economic damages from European green crab predation to commercial and recreational shellfisheries and eelgrass restoration efforts range from $18.6 to $22.6 million per year in the United States (EPA, 2008a).

- ***Round Goby:*** The round goby, native to Eurasia and likely introduced via ballast water, is thought to have adverse impacts on fisheries, due to its lack of value as a sport or commercial catch and its aggressive tendencies toward baited lines. Fishermen report that they are sometimes able to catch only gobies when fishing for the more desirable walleye (Marsden and Jude, 1995). No attempts to quantify the value of these impacts have been made to date.

- ***Zebra Mussel:*** An invasion of zebra mussels, which are native to the Caspian Sea and were introduced to U.S. waters in ballast water, has led to a halt in the $3 billion dollar Mississippi River shellfishing industry (Randall, 2001).

- ***Pathogens:*** Pathogens transported in ballast water can also have significant adverse impacts on fisheries. Infectious salmon anemia (ISA) has been a persistent problem in U.S. Atlantic fisheries' stocks since 2001. The original source and vector of this pathogen is unknown. Though there has been no attempt to quantify damages to the U.S. economy specifically from ISA, it is estimated that the annual cost in 1999 was $11 million in Norway, $14 million in Canada and $32 million in Scotland (Cipriano and Miller, 2002).

  Another recent fish pathogen of concern has been viral hemorrhagic septicemia (VHS). VHS has been known to exist in the coastal regions since the late 1980s, but only recently migrated into the Great Lakes through an unknown vector (USDA, 2006). An unpublished study found that VHS has impacted 6 of 23 fish species caught commercially in the Great Lakes, including two that account for 76 percent of the entire $13.5 million dollar harvest (Lovell and Drake, 2007). In 1991, an exotic strain of *Vibrio cholerae* (epidemic cholera) was identified in oysters in Mobile Bay on the Gulf Coast. The estimated economic losses due to the closure of oyster harvesting in Mobile Bay for five months in 1991 as a response to concerns about epidemic cholera contamination were $726,000 (2007$) (Lovell and Drake, 2007).

  Two non-native pathogens, MSX (*Haplosporidium nelsoni*) and Dermo (*Perkinsus marinus)* have caused substantial damages to native oyster populations in several U.S. coastal regions. Though the original vector of introduction is unknown for both pathogens, ballast water is considered to be one potential source of MSX, and Dermo is known to transmit relatively easily between infected and uninfected oysters (McKnight, 2007; Ewart and Ford, 1993).

OTHER WATER-BASED RECREATION AND TOURISM

ANS have also had adverse impacts on recreation and tourism nationwide by damaging water quality and flow. Two invasive plants, hydrilla and water lettuce, have caused significant damages in U.S. waters. Both clog the water's surface, blocking boating and swimming, impeding water flow, and disrupting plant and animal communities. Florida spends an estimated $1 million or more annually to control water lettuce, and the rest of the Eastern U.S. states spend approximately $100,000 annually (Van Driesche et al., 2002). Studies of two lakes in Florida affected by hydrilla found that degradation caused by the hydrilla cost the state $11 million in lost recreation expenditures (Pimentel et al., 1999).[63]

Invasive mollusks such as zebra mussels can also adversely affect a number of recreational activities, including boating and swimming. Zebra mussels often cover shorelines with sharp-edged shells and rotting mussel flesh, which can diminish interest in visiting infested beaches.

[63] This cost may have an adverse impact locally, but because the money is still available to be spent elsewhere, this adverse impact does not represent a true net welfare loss.

Biofouling can also be a deterrent to recreational boaters who would rather avoid zebra mussel fouling and the resulting necessity of extensive vessel cleaning (USACE, 2002). A study by Vilaplana and Hushak (1994) estimated that incremental annual costs to boat owners in the Great Lakes related to the mussel included $94 for protective anti-fouling paints, $171 for additional maintenance, and $207 for insurance.

BIODIVERSITY AND ECOSYSTEMS

Introductions of ANS can drastically alter virtually every characteristic of an aquatic ecosystem. ANS can affect the "composition, density, and interactions of native species" that can then cause "significant changes to the ecosystem, such as alterations to the food webs, nutrient dynamics and biodiversity" (IDNR, 2003). Ecosystems provide a variety of services, including water quality maintenance, detoxification and decomposition of waste, climate stabilization, mitigation of natural disaster impacts, and a source of income. Several significant instances of adverse ecosystem impact include:

- ***Zebra Mussel:*** Zebra mussels have had some of the most dramatic impacts observed to date on ecosystems, particularly in the Great Lakes region. The mussels achieved densities as high as 700,000 per square meter, which led to a much greater filtration rate of particulate matter, resulting in much lower turbidity (Griffiths et al., 1991; MacIsaac et al., 1995). This in turn led to much greater filtration of light through the water column, which affected plant viability and substantially increased competition for food for indigenous mollusks.
- ***Round Goby:*** The round goby was first introduced into the Great Lakes region via ballast water. The goby preys on benthic fauna competing with species native to the Great Lakes and takes over prime spawning sites of native species, which is changing the balance of the ecosystem. Introduction of the round goby adversely affected a number of native species, including mottled sculpin, logperch, and darters. Due in part to the threat posed by the Round Goby and the Asian Carp, the U.S. Army Corps of Engineers and U.S. EPA have spent $1.2 million to erect a dispersal barrier to prevent its further spread down the Chicago Sanitary and Ship Canal to the Mississippi River (Glassner-Shwayder, 1999).
- ***European Ruffe:*** The European ruffe preys on native fish and competes with them for habitat. It was introduced into the Great Lakes via ballast water and poses a serious threat to species like the walleye, yellow perch, and whitefish (Leigh, 1998). Populations of spawning European ruffe in the St. Louis River went from 200,000 in 1989 to 1.8 million in 1991. At the same time, populations of yellow perch, troutperch, emerald shiners, and spottail shiners decreased by 75 percent (RTF, 1992). The expected reduction in value of sport and commercial fisheries in the Great Lakes region due to the ruffe invasion is $119 million (ANSTF, 2007).
- ***Snowflake Coral:*** *Carijoa riisei*, or snowflake coral, an invasive coral species, is threatening the ecosystem stability of the ecologically sensitive Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (NOAA, 2004a; Toonen, 2005). It is also a threat

to the native black coral, which a local industry valued at $30 million harvests and uses to make jewelry.

THREATENED AND ENDANGERED SPECIES

Invasions have had especially adverse impacts on threatened and endangered species by predation, alteration of habitat, or further competition for limited resources. It is estimated that non-indigenous species are a contributing factor to the endangered status of 70 percent of listed fish species, and more than half of combined endangered and threatened listings (OTA, 1993). They are also estimated to have contributed to 68 percent of fish extinctions in the last 100 years (Larson and Sytsma, 2006).

DAMAGE TO INFRASTRUCTURE

Industrial facilities, such as those that purify water, generate electricity, and manufacture goods, depend on water intake structures to perform their services. These structures can often be adversely affected by ANS.

So far, zebra mussels have been the most damaging ANS introduced into U.S. fresh waters, causing particularly severe problems with water intake structures (USACE, 2002). Zebra mussels attach to surfaces of water intake structures, navigation dams, pumping stations, and gears, often making them inoperable, which inconveniences the public and costs industry significant financial losses and damages (USACE, 2002).

Hushak (1996) reports on the results of 398 surveys of Great Lakes users with lake water intake structures from 1989 to 1994 for private and public utilities, municipal water facilities, and industrial users. Extrapolating the results of this survey to all facilities in the Great Lakes yielded total monitoring and control costs of $120 million from 1989 to 1994 with an average cost of $30 million annually (Park and Hushak, 1998). Another study done in 1995 of the economic impact of zebra mussels (O'Neill, 1997) found that the total costs of zebra mussels control and monitoring were $69 million, with a mean cost of $205,570 per facility. The study results also showed that total annual expenses rose from $234,140 in 1989 to $17,751,000 in 1995 as the range of mussels increased (O'Neill, 1997).

Another invasive bivalve species, the Asian clam, is estimated to have caused fouling damage that cost the nuclear industry about $1 billion per year in the early 1980s (OTA, 1993). Two other invasive bivalves, the brown mussel and the green mussel, have also caused fouling damages in the Gulf Coast region and Tampa Bay, respectively, where each has become established, although the total economic value of the damages is not known (Benson et al., 2002; GSMFC, 2003).

Finally, invasive plant species such as hydrilla and water hyacinth can disrupt water flow in irrigation canals and in utility cooling reservoirs. Annual expenditures on aquatic weed control in the United States, much of which is spent on ANS weeds specifically, are estimated at $110 million (Pimentel et al., 2005).

HUMAN HEALTH IMPACTS

Though the exact nature of the link between human health impacts and ANS invasions through ballast water is poorly understood, studies have established that pathogenic invasive species can be transported in ballast water (Ruiz and Reid, 2007). Moreover, in the case of epidemic cholera, a serious human pathogen, the presence of non-native strains was previously confirmed in U.S. waters (CDC, 1993). The potential human health impacts associated with ballast water transport are an object of increasing concern. Some pathogenic bacteria identified in ballast water known to be associated with adverse human health impacts include *E. coli*, enterococci, *Vibrio cholerae*, *Clostridium perfingens*, *Salmonella spp*. *Cryptosporidium spp*., and *Giardia spp.*, as well as a variety of viruses (Knight et al., 1999; Reynolds et al., 1999; Zo et al., 1999).

In July 1991, a strain of *Vibrio cholerae* was identified in oysters in Mobile Bay on the Gulf Coast that was indistinguishable from a Latin American strain not endemic to the United States. An investigation indicated that the pathogen was most probably introduced from the discharge of contaminated ballast water (CDC, 1993). Because oysters are often eaten raw, this is a potential human health threat. Of the 61 cases of cholera in the United States between 1995 and 2000, 14 were caused by the consumption of undercooked seafood (Steinberg, 2001). Though it is unclear whether any of these cases were caused by exotic strains of *Vibrio cholerae*, this evidence clearly indicates that the potential exists for the transport of harmful non-native pathogens in ballast water.

As mentioned in the introduction to this section, a study by NOAA also showed the potential for pathogens to be transported in ballast water tanks, even when they are not filled. The study found that virus-like particle concentrations in sampled ballast tanks ranged from 10^7 to 10^9 per ml in residual unpumpable ballast water and from 10^7 to 10^{11} per ml in sediment porewater. Bacteria concentrations under the same conditions were 10^5 to 10^9 per ml and 10^4 to 10^8 per ml, respectively (Johengen et al., 2005). As in the 2008 VGP, and as an interim requirement in the 2013 VGP (to be phased out as treatment is required), saltwater flushing in vessels with empty ballast tanks will assist in reducing these risks by removing sediments may reduce the potential for pathogen contamination.

Ballast water is also a vector for the microorganisms associated with the "red tide" or harmful algal bloom phenomenon. This phenomenon occurs when certain species of algae release toxins into an aquatic environment, which adversely impacts aquatic life and can also impact human health if fish contaminated with the toxin are consumed (WHOI, 2007). Although current USCG mandatory BMPs for all vessels with ballast tanks, codified in 33 CFR 151, require vessels not to take up ballast water in areas known to be contaminated with such organisms, the new Permit's requirements governing ballast exchange may further reduce the spread and impact of these organisms.

6.1.3 EFFICACY OF VGP BALLAST WATER MANAGEMENT PRACTICES

The incorporation of ballast water discharge standards in the 2013 VGP is expected to provide benefits through a reduction in the concentration of living organisms, leading to lower numbers of these organisms being introduced per discharge. While the ballast water management practices generally follow those required under the USCG and IMO standards, additional monitoring, sampling, testing, and reporting requirements contained in the 2013 VGP will help further this benefit by verifying that BWTS perform according to their design specifications and meet the discharge limits. This overall strategy should reduce the number of new invasions because the likelihood of establishment increases with the number of organisms introduced per discharge or inoculation (Ruiz et al. 2000a, Minton et al. 2005). Thus, enhanced monitoring requirements may help increase the effectiveness of BWTS in reducing the mean rate of invasion, although the magnitude of this effect is difficult to quantify; the USCG estimated that increasing the effectiveness of BWTS from 37 to 63 percent leads to annual avoided costs going from $155 million to $264 million, per year, when using a mid-point control cost estimate, at a 3 percent discount rate (USCG, 2012a).

6.1.4 BENEFITS OF REDUCING ANS INTRODUCTIONS

The evidence presented in *Section 6.1.2: ANS Impacts* demonstrates that introductions of ANS through ballast water are associated with significant detrimental impacts throughout the United States. The ballast water provisions of EPA's final Vessel General Permit, to the degree that they fill a gap in the existing ballast water management practices, can therefore be expected to generate benefits by reducing the risk of such damages in the future. Benefits would include the prevention of damages to fisheries, tourism, and recreation, of damages to infrastructure, and of adverse human health impacts, as well as prevention of further stresses on native biodiversity and ecosystems.

The issue of ANS invasions and their impacts presents unique challenges for the estimation of the benefits associated with this Permit. Although ballast water is one of the major pathways of invasive species introduction, estimating changes in risk of introduction of invasive species from the Permit requirements is not feasible due to the lack of data on rates of invasive species introduction associated with ballast water releases. Moreover, because the type of species introduced in the future is unknown and the range of potential economic impacts associated with each species type is very large, estimating the monetary value of benefits from preventing future invasions with a reasonable degree of certainty would not be possible.

COMMERCIAL AND RECREATIONAL FISHERIES

A reduction in the number of ANS introductions due to the final ballast management requirements and other Permit requirements may prevent significant future damages to commercial and recreational fisheries that play a critical role in the U.S. economy. In 2009, 7.9 billion pounds of fish and shellfish were landed by U.S. commercial fishermen at U.S. ports, and were valued at $3.9 billion (NMFS, 2010). An additional 29.9 million anglers aged 16 and older spent an average of 17 days fishing in 2006, spending more than $40 billion dollars on trips, equipment, licenses, and other costs (USDOI, 2007). Leigh (1998) estimated the annual reduction in value of yellow perch, walleye, and whitefish fisheries due to ruffe invasion under moderate scenario assumptions to be $119 million (in 1998 dollars; $159 million (2010$) inflated using the Consumer Price Index (CPI)).

OTHER WATER-BASED RECREATION AND TOURISM

Another source of potential benefits from the reduction of ANS introductions under the Permit will be the prevention of damages to valuable recreation and tourism sites. A report by NOAA (2004b) estimated the annual revenue associated with coastal tourism in the United States to be

$54 billion, and found that beaches are the most popular tourist destinations in the United States. One invasive plant species alone, hydrilla, is associated with $14.5 million annually in control costs, and reduces lake recreation on two Florida lakes alone by $11 million in years when hydrilla covers the lakes (Pimentel et al., 1999). Since data are limited on the impacts of invasive species on recreation and tourism in ecosystems for which estimated rates of invasion exist, it is not possible to calculate the level of expected benefits for other water-based recreation and tourism. However, EPA projects that there will be some incremental benefits.

BIODIVERSITY AND ECOSYSTEMS

Additional significant benefits from the Permit will accrue to biodiversity and ecosystems. As detailed in *Section 6.1.2: ANS Impacts,* ANS are associated with substantial adverse impacts on the composition of ecosystems and the biodiversity therein. The quantification of biodiversity benefits will not be attempted in this analysis due to the great deal of uncertainty surrounding the impact of a single ANS introduction on a given ecosystem relative to other factors, as well as the difficulty of predicting the rate of ANS introduction. However, potential benefits in the form of preservation of habitat and species are likely.

THREATENED AND ENDANGERED SPECIES

The Permit requirements for ballast water management, by reducing the impacts of invasive species introductions on threatened and endangered species, will have benefits in terms of prevention of reduction in species population and species extinction. Total federal spending nationwide on programs related to the Endangered Species Act for 2004, the most recent year for which data are available, was more than $1.2 billion, and state spending was more than $200 million (USFWS, 2005).

As mentioned above, ANS are considered likely contributors to the threatened or endangered status of 70 percent of listed fish species (Larson and Sytsma, 2006). Combined federal and state expenditures per listed species of fish in 2004 ranged from $25,000 to $1.09 million (USFWS, 2005). It is not possible to calculate a range of benefits to threatened and endangered species associated with EPA's Permit requirements, due to the lack of research linking specific invasions with quantifiable impacts on particular species. However, it is likely that some proportion of potential future expenditures on endangered and threatened fish, as well as expenditures on other aquatic endangered species, would be averted by reduced ANS introductions under the Permit requirements.

DAMAGE TO INFRASTRUCTURE

Another benefit of the Permit requirements for ballast management will result from averting damages to infrastructure by invasive species of plants and mollusks. Fouling by species such as the Asian clam, zebra mussel, and hydrilla has caused substantial economic damage to a variety of municipal and industrial entities in the past. Most of this damage takes the form of clogging water intake structures and disrupting the flow of water. One study estimated fouling damage to water intake infrastructure by zebra mussels for the year 2000 to be $5 billion (Khalanski (1997), and cited in Pimentel et al. (1999); $6.1 billion in 2007$ using CPI).

HUMAN HEALTH

Estimating expected human health benefits of EPA's Permit is not feasible due to very limited data on the rates of non-endemic pathogen invasions and the human health effects of these pathogens. Nevertheless, the Permit provisions are likely to reduce the probability of introduction of harmful exotic pathogens and thus are expected to benefit human health.

SUMMARY OF BENEFITS

The ballast water discharge standard and management practices established in the 2013 VGP are designed to directly address the likelihood of future ANS invasions. The categories of potential damages from such ANS invasions have been discussed above, and studies referenced as to the potential magnitude of these damages for each. To the degree that these damage estimates provide an indicator of the likely payback that can be anticipated from reducing ANS invasions, EPA believes the benefits of this Permit can be expected to be very significant. However, the complexity of analyzing the probability of ANS introduction and spread, the wide range and varied nature of impacts ANS invasions can cause, and the great breadth of the scope of this Permit prohibit EPA from developing a quantified estimate of these benefits.

6.2 BENEFITS OF REDUCED POLLUTANT DISCHARGES FROM VESSELS

6.2.1 INTRODUCTION AND BACKGROUND

The Clean Water Act and its associated regulations have greatly improved the quality of the nation's waters over the past 40 years. Nevertheless, large portions of the United States' fresh and saline waters remain degraded by elevated concentrations of harmful pollutants. As summarized by EPA, 50 percent of assessed rivers and streams; 66 percent of assessed lakes, ponds, and reservoirs; 64 percent of assessed bays and estuaries; and 38 percent of coastal shorelines were classified as impaired for at least one of their designated uses (EPA, 2011).[64] Impairments of designated uses – the protection and propagation of fish, shellfish, and wildlife and the harvesting of aquatic life, among others – are associated with a variety of economic and ecological damages. The causes of impairment vary by waterbody, but commonly include pathogens, oxygen enrichment/oxygen depletion, nutrients, metals, turbidity, oil and grease, and nuisance exotic species. [65]

As detailed in EPA's 2010 study, several of these causes have associated pollutants that have be found in discharges incidental to the normal operation of vessels. For example, EPA found significant concentration of nutrients in deck runoff, graywater, bilgewater, and fish hold tanks.

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[64] States are responsible for assessing impairment of water bodies. States assessed 26 percent of rivers and streams; 42 percent of lakes, ponds, and reservoirs; 21 percent of bays and estuaries; and 4 percent of coastal shorelines in the reporting cycle summarized in this report (generally ranging from 2002 and 2010, depending on the state, with data for most states reflecting assessments completed as of 2008).

[65] The risk of introduction of ANS is discussed in the next section.

The 2013 VGP contain several new provisions aimed at reducing pollutant loadings incidental to vessel operation, either by minimizing the introduction of pollutants in the vessel effluents (e.g., use of environmental preferred cleaners or lubricants), employing treatment technologies to decrease pollutant loadings in the discharges, and by requiring regular inspection and monitoring to identify and address potential problems. In the section below, we describe the types of pollutants that may be found in vessel discharges and discuss how the 2013 VGP revisions may help reduce loadings of these pollutants to waters of the U.S. and therefore generate potential benefits for aquatic ecosystems. These benefits will be likely to occur mostly in waterways receiving the greatest amount of vessel traffic.

The Permit covers many discharges and contains special provisions for numerous vessel types. Because of the breadth of coverage and provisions in the Permit, the following discussion does not address all of these provisions individually, but focuses on the more important changes in Permit requirements for certain types of vessel discharges.

6.2.2 POLLUTANTS COMMONLY FOUND IN VESSEL DISCHARGES

The numerous individual harmful constituents of vessel discharges may be grouped into six broad categories: nutrients, pathogens, oil and grease, metals, other pollutants with toxic effects, and other non-toxic pollutants. Many of the 27 types of discharges covered by EPA's Permit are associated with one of these six types of pollution. *Table 6-3* summarizes pollutant types potentially reduced by Permit requirements.[66]

Table 6-3. Pollutants Found in Vessel Discharges[a].

Type of Discharge	Nutrients	Pathogens	Oil & Grease	Metals	Other Toxics	Other Non-Toxics
Deck Runoff	X		X	X	X	X
Bilgewater	X		X	X	X	
Anti-fouling Hull Coating				X	X	
AFFF					X	
Boiler Blowdown					X	X
Cathodic Protection				X		
Chain Locker Effluent			X	X		
Controllable Pitch Propeller Hydraulic Fluid			X	X		
Elevator Pit Effluent	X			X	X	
Firemain Systems	X			X	X	X
Freshwater Layup					X	
Gas Turbine Wash Water			X		X	
Graywater	X	X	X	X	X	X

[66] The effect of ballast water provisions on risk of introduction of ANS is discussed in the preceding section.

Type of Discharge	Nutrients	Pathogens	Oil & Grease	Metals	Other Toxics	Other Non-Toxics
Motor Gasoline and Compensating Discharge				X	X	
Non-Oily Machinery Wastewater			X	X	X	
Refrigeration and Air Condensate Discharge			X		X	
Rudder Bearing Lubrication Discharge			X			
Seawater Cooling Overboard Discharge				X		X
Seawater Piping Biofouling Prevention					X	
Small Boat Engine Wet Exhaust			X		X	
Sonar Dome Discharge				X	X	
Underwater Ship Husbandry				X		
Welldeck Discharges	X	X	X	X	X	X
Fish hold effluent	X	X	X	X	X	X

Source: Battelle (2007)

a. Other Permit requirements that could not be firmly linked to one of these six categories of pollutants are excluded from the table

Several types of discharges address by revisions to the VGP have particularly significant pollutant constituents and therefore also may be associated with substantial incremental benefits. They are described in more detail below.

GRAYWATER

Untreated graywater contains multiple constituents of concern, including pathogenic bacteria, toxic and carcinogenic organic and inorganic compounds, nutrients, and metals (EPA, 2008b; EPA, 2010b). *Table 6-4* summarizes the rates of discharge for major pollutants found in graywater in an EPA survey of cruise ships. The same survey found that total graywater discharge volumes ranged from 36 to 119 gallons/day/person, with a mean value of 67 gallons/day/person.

Table 6-4. Types of Pollutants Found in Graywater Discharges

Type of Discharge	Average Concentrations of Pollutants[a]	EPA NRWQC Standard[b]
Ammonia – Nitrogen	2130-2210 µg N/L	2140-15,600 µg N/L CMC, 321-2960 µg N/L CCC
Nitrate	0.009-0.0872 mg/L	------
Total Kjeldahl Nitrogen	11.1-26.2 mg/L	------
Total Phosphorus	3.34-10.1 mg/L	------
Fecal Coliform	2,950,000 MPN/100 mL	43 MPN/100 mL
Enterococci	8920 MPN/100 mL	35 MPN/100 mL
Hexane Extractable Material[c]	78-149 mg/L	------
Arsenic	1.22-2.25 µg/L	0.14 µg/L
Copper[d]	483-510 µg/L total, 195 µg/L dissolved	74 µg/L CMC, 8.2 µg/L CCC

Type of Discharge	Average Concentrations of Pollutants[a]	EPA NRWQC Standard[b]
Nickel	29.7-48.7 μg/L total, 18.2 μg/L dissolved	4.8 μg/L CMC, 3.1 μg/L CCC
Thallium	0.93 μg/L total, 0.403 μg/L dissolved	0.47 μg/L (in shellfish)
Zinc	790-2540 μg/L total, 1610 μg/L dissolved	90 μg/L CMC, 81 μg/L CCC
Bis(2-ethylhexyl) phthalate	22.4-71.9 μg/L	2.2 μg/L
Tetrachloroethylene	10.7-11.4 μg/L	3.3 μg/L
Phenol	1.16-52.5 μg/L	------
Total Residual Chlorine[e]	372 μg/L	13 μg/L CMC, 7.5 μg/L CCC
Chlorides	125 mg/L	------

Source: EPA (2007a)

Note: Because of the quantity of metals and toxics detected, only pollutants exceeding EPA's national recommended water quality criteria (NRWQC) or pollutants discussed elsewhere in this analysis are listed here.

a Ranges presented in this table represent differences in reported concentrations between data from the Alaska Cruise Ship Initiative of the Alaska Department of Environmental Conservation (ACSI/ADEC), and EPA's own data, both presented in EPA (2007a).

b EPA has not set NRWQC for all pollutants of interest. CCC is an abbreviation for Criterion Continuous Concentration, a long-term measure of pollutant loading. CMC is Criterion Maximum Concentration, a short-term measure.

c Hexane extractable material is considered an indicator of level of oil and grease contamination.

d ACSI/ADEC did not conduct separate sampling for dissolved metals, so a range is not listed for dissolved metals.

e EPA did not sample total residual chlorine; ACSI/ADEC did not sample chloride.

Prior to the promulgation of the 2008 VGP, discharges of graywater had been largely unregulated at the federal level in the territorial waters of the United States, with two exceptions: the Great Lakes, where graywater discharges must be treated similarly to sewage discharges under the Clean Water Act; and the territorial waters of Alaska, where graywater discharges by cruise ships within the territorial waters are subject to discharge standards. Maine, Washington, Hawaii, and Florida also have state-level programs to reduce the impacts of graywater discharges from cruise ships.

Under the revised VGP, vessels that discharge treated graywater within 1 nm of shore will have to comply with new monitoring requirements to help ensure the proper functioning of their treatment system. Releasing large volumes of untreated graywater in nearshore environments, estuarine environments, or in waters with limited circulation is more likely to cause negative environmental impacts. This is because these environments are likely to have higher vessel traffic and, therefore, greater graywater generation and discharge, are more likely to be stressed by other anthropogenic forces, and are likely to have less ability for dilution and assimilative capacity. The revised VGP clarifies that the graywater requirements also apply to vessels operating on the Great Lakes that are not commercial vessels, as defined in CWA section 312(a)(10), which will help protect the ecosystem of the Great Lakes.

BILGEWATER

Bilgewater is water from a variety of sources, including wastewater and leakage, which drains into a compartment in a vessel's inner hull. While its composition and physical-chemical characteristics can vary widely, both over time and between different vessels, bilgewater typically contains various hydrocarbons and fuels, grease, antifreeze, hydraulic fluids, cleaning and degreasing solvents, detergents, metals (arsenic, copper, cadmium, chromium, lead, mercury, selenium and zinc), catalytic fines, soot, and other solid particles (sludge) (EPA, 2008a).

Among the constituents of bilgewater, oils and greases are a primary concern. Oil is present in free form, dispersed, or emulsified. Oil/hydrocarbon concentrations in vessel bilges commonly fall in the 100 to 400 ppm range (US Navy 1999-2000). Ghidossi et al., (2009) reported a somewhat higher 500 ppm oil concentration in the bilgewater of a ferry. Water accumulating in a vessel's bilge spaces is periodically pumped to a holding tank to maintain vessel stability and prevent hazardous conditions resulting from its accumulation. The bilgewater can then be managed either by retaining it onboard and later discharging it to a reception facility on shore, or treating it onboard with a bilge separator to meet applicable standards and regulations. Existing regulations are based on Annex I of the MARPOL 73/78 and require all vessels weighing more than 400 tons to have equipment that limit the discharge of oil into the oceans to 15 ppm when the vessel is en route. However, this practice does not eliminate all oil and grease from discharges, but merely reduces it to a level below 15 ppm.

EPA's VGP revisions address this gap by retaining existing requirements governing untreated bilgewater but providing incentive for vessels to reduce their oil and grease concentration limit for discharges of treated bilgewater to 5 ppm. Further, several of the more advanced treatment systems that can reduce effluent concentrations to below 5 ppm also reduce concentrations of other pollutants. For example biological treatment systems degrade oils while also removing other organic pollutants such as glycols, solvents, detergents, nitrogen, and phosphate. Use of these systems may therefore be beneficial beyond their ability to reduce oil pollution into receiving waters.

ENVIRONMENTALLY-ACCEPTABLE LUBRICANTS

The 2013 VGP mandates the use of environmentally-acceptable lubricants (EALs) in oil-to-sea interface applications for existing vessels (subject to technical feasibility) and for all new build vessels. While use of EALs has been increasing in the last decade, revisions to the VGP will further increase the use of these products, and result in decreased environmental impact from the operational discharges of oil. Because the majority of a lubricant is composed of the base oil, the base oil used in an EAL must be biodegradable. The three most common categories of biodegradable base oils are: 1) vegetable oils, 2) synthetic esters, and 3) polyalkylene glycols. Traditional mineral oils have a small biodegradation rate, a high potential for bioaccumulation and a measurable toxicity towards marine organisms. In contrast, the base oils derived from oleochemicals (vegetable oils and synthetic esters) degrade faster and have a smaller residual, do not bioaccumulate appreciably and have a lower toxicity to marine organisms. Polyalkylene glycol-based lubricants are also generally biodegradable and do not bioaccumulate; however, some PAGs are more toxic due to their solubility. Lower environmental impacts will occur when a greater proportion of base oils are manufactured from non-mineral based oils.

6.2.3 POLLUTANT IMPACTS

Vessel discharges contain a wide variety of pollutants with the potential to cause ecological and economic harm to aquatic species and their habitat. The relationship between types of pollutants and associated discharges was summarized in *Table 6-3,* above.

OIL AND GREASE

Oil and grease are a component of vessel discharges with potentially harmful impacts to humans and to aquatic life. Oil in vessel discharges is required to be discharged in concentrations that may not be harmful, consistent with existing regulation under 40 CFR part 110. The Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), a United Nations body, found that voluntary vessel discharges account for less than 1 percent of vessel oil discharges into the marine environment (GESAMP, 2007). However, vessel discharges may still contain enough oil to do ecological damage, even if they meet existing concentration requirements and account for a small percentage of total oil discharges worldwide. Oils are highly toxic and carcinogenic, and may inhibit reproduction and cause organ damage or even mortality (AMSA, 2003). Additionally, oil can taint organisms that are consumed by humans, which is a potential source of adverse health impacts.

The 2013 VGP strengthens requirements applicable to several oil discharge categories to minimize and reduce discharges of oil and grease from several sources, including during bilgewater and oil-to-sea interfaces. For bilgewater, for example, the permit sets strict requirements for the monitoring of any treatment system present onboard a vessel. The 2013 VGP also mandates the use of environmentally acceptable to reduce loading of harmful compounds into the aquatic environment.

NUTRIENTS

Nutrient pollution, including nitrogen and phosphorus, is a component of vessel discharges and a major source of water quality degradation throughout the United States (USGS, 1999). Though traditionally associated with agricultural runoff from fertilizer, sewage treatment facilities, and urban stormwater, a variety of other sources do exist, including graywater and bilgewater discharges from ships. Revisions to the VGP requirements applicable to these types of discharges are expected to reduce loadings of nutrients to receiving waters.

Nutrient pollution is associated with a variety of negative environmental impacts, the most notable of which is eutrophication, which can lead to reduced levels of dissolved oxygen due to increased demand (sometimes to the extremes of hypoxia), reduced levels of light penetration and turbidity, and changes in the composition of aquatic flora and fauna (National Research Council, 2000). It also helps to fuel harmful algal blooms that can have devastating impacts on both aquatic life and human health, if affected organisms are consumed (WHOI, 2007). The impacts of these water quality reductions on recreation and fishing can be significant, particularly in estuaries. For example, a 1989 study found that a hypothetical 20 percent reduction in nitrogen and phosphorus loading in the Chesapeake Bay would result in an increase in recreation worth $34.6 million (in 1984 dollars) from increased public beach usage (National Research Council, 2000). Nutrient pollution has also contributed to the decline of the Chesapeake crab fishery, due to its role in degrading underwater vegetation, which serves as an important habitat for post-larval crabs (Maryland DLS, 2005).

PATHOGENS

Pathogens are another important constituent of discharges from vessels, particularly in graywater. EPA's study of graywater discharges from cruise ships found that levels of pathogen indicator bacteria exceeded enterococci standards for marine water bathing and fecal coliform standards for harvesting shellfish 66 percent and over 80 percent of the time, respectively (EPA, 2008b). Specific pathogens of concern found in graywater include *Salmonella*, *E. coli*, enteroviruses, hepatitis, and pathogenic protists (National Research Council, 1993). Elevated levels of these pathogens have increasingly resulted in beach closures in recent years, which in turn have reduced the recreational value of impacted beaches (NRDC, 2005).

Though it is difficult to determine the precise contribution of vessel discharges to infections by these organisms, epidemiologists have attempted to quantify the proportion of total infections that are waterborne. For example, waterborne infection may account for as many as 60 percent of *Giardia* infections and 75 percent of pathogenic *E. coli* infections (National Research Council, 1993). Graywater discharges are a significant source of pathogenic microorganisms within the regulated waters, and reducing them, for example through strengthening VGP graywater treatment requirements, will likely provide non-negligible human health benefits.

METALS

Metals are a diverse group of pollutants, many of which are toxic to aquatic life and humans. Vessel discharges can contain a variety of metal constituents. For example, EPA's study of cruise ship graywater found a total of 13 different metals in at least 10 percent of samples, with copper, nickel, and zinc detected in 100 percent of samples (EPA, 2008b). Bilgewater also contains these constituents and likely others (Battelle, 2007).

While some metals, including copper, nickel, and zinc, are known to be essential to organism function, many others, including thallium and arsenic, are non-essential or are known to have only adverse impacts. Even essential metals can do serious damage to organism function in sufficiently elevated concentrations. Adverse impacts can include impaired organ function; impaired reproduction and birth defects; and, at extreme concentrations, acute mortality. Additionally, through a process known as bioaccumulation, metals may not be fully eliminated removed from blood and tissues by natural processes, and may accumulate in predator organisms further up the food chain (EPA, 2007b). This process can result in adverse health impacts for humans, who may consume contaminated fish and mollusks.

However, the impacts of metals on any given ecosystem are difficult to predict, due to the relatively complicated circumstances by which they are available to organisms. Bioavailability of metals, and therefore impacts, varies by species of organism, as well as by climate and chemistry of a water body (John and Leventhal, 1996). Moreover, background levels of metals can vary substantially by location (EPA, 2007b).

OTHER POLLUTANTS WITH TOXIC EFFECTS

The term "other pollutants with toxic effects," as it applies to constituents of vessel discharges, encompasses a variety of chemical compounds known to have a broad array of adverse impacts on aquatic species and human health. For example, EPA's study of cruise ship graywater found a total of 16 different volatile and semi-volatile organic compounds in at least 10 percent of samples, for which the most significant rates and levels of detection were phthalates, phenol, and tetrachloroethylene. Other notable pollutants with toxic effects detected included free residual chlorine and chlorides.

These compounds can cause a variety of adverse impacts on ecosystems, including fisheries, as well as on human health. Phthalates are known to interfere with reproductive health and liver and kidney function in both animals and humans (Sekizawa et al., 2003; DiGangi et al., 2002). Chlorine, though toxic to humans at high concentrations, is of much greater concern to aquatic species, which can experience respiratory problems, hemorrhaging, and acute mortality even at relatively low concentrations (EPA, 2007a).

OTHER NON-TOXIC POLLUTANTS

The category "other non-toxic pollutants" includes all non-conventional pollutants except fecal coliform (discussed in pathogens) as applied to vessel discharges also consists of multiple pollutants with disparate impacts. The most important types are pH pollution and thermal pollution, which can be found in several of the discharges that will be reduced a as a result of VGP revisions, including graywater and bilgewater.

Some vessel discharges are more acidic or basic than the receiving waters, which can have a localized effect on pH (ADEC, 2007). Though no research has been done linking vessel pollution specifically to pH impacts on aquatic ecosystems, extensive literature on the impacts of pH changes in the contexts of aquaculture and acid rain does exist. For nearly all fish populations, pH more acidic than 5 or more basic than 10 will cause rapid mortality, and many individual species are sensitive to more moderate changes in pH (EPA, 2007e; Wurts and Durborrow, 1992).

Some vessel discharges may also be warmer or colder than the ambient temperature of the receiving water, which can affect temperature locally (Battelle, 2007). Thermal impacts of vessel discharges are generally much smaller than those from better-known sources such as dams, power plant cooling water, and runoff, due to scale. However, even small temperature changes can impact some sensitive organisms' growth, reproduction, and even survival, which implies that some vessel discharges may have adverse impacts on aquatic ecosystems, and also fisheries (Abbaspour et al., 2005; Cairns, 1972; Govorushko, 2007).

6.2.4 BENEFITS OF REDUCING POLLUTANT DISCHARGES

Many of the nation's busiest ports are considered to be impaired by a variety of pollutants found in vessel discharges, as is summarized in *Table 6-5.* The Permit is expected to reduce discharges of nutrients, metals, oil, grease, toxics, and other pollutants in waters with high levels of vessel traffic.

Table 6-5. Impairment Status of the Top 20 Ports by Annual Vessel Calls.

Port	Impairments by Pollutants Found in Vessel Discharges
Houston, TX	Bacteria, Nutrients[a]
New York City, NY	Nitrogen, Oxygen Demand,[b] Cadmium, Mercury
Port Everglades, FL	Fecal Coliform, Dissolved Oxygen, Nutrients
Miami, FL	None listed
Los Angeles/Long Beach, CA	Polycyclic Aromatic Hydrocarbons (PAHs),[c] Zinc, Copper, Chromium, Lead, Mercury, Cadmium, Nickel
San Juan, PR	Ammonia, Fecal Coliform, Dissolved Oxygen
Savannah, GA	Mercury, Dissolved Oxygen
St. Thomas, Virgin Islands	Dissolved Oxygen, Fecal Coliform, Oil and Grease, pH
Seattle, WA	PAHs, Fecal Coliform, pH
New Orleans, LA	Fecal Coliform
Charleston, SC	None listed
Baltimore, MD	Zinc, Chromium
Elizabeth River, VA	Phosphorus, Fecal Coliform
Oakland, CA	Mercury, Selenium
Bayou Lafourche, LA	Dissolved Oxygen, Nutrients, Total and Fecal Coliform
Galveston, TX	Bacteria
Tacoma, WA	Bis(2-ethylhexyl) phthalate, PAHs
Jacksonville, FL	Coliform, Nutrients, Turbidity
South Louisiana, LA	Fecal Coliform

Source: Battelle (2007)

a Two of the listed pollutants are found in the areas surrounding the shipping route through the Bay of Galveston to Houston, rather than in the Port of Houston itself.

b Oxygen demand is associated with eutrophication (see the subsection on Nutrient pollution).

c PAHs are a subset of volatile and semi-volatile organic compounds and are associated with petroleum products

The evidence presented in the pollutant impacts section demonstrates that vessel discharges are associated with significant detrimental impacts throughout the United States. Stronger controls on specific discharges contained in 2013 VGP, as well as general housekeeping requirements of the Permit, can be expected to generate benefits through reducing the risk of damages in the future and making water quality improvements in already-impaired waters. Monetized benefits will include the prevention of fishery closures and of adverse human health impacts, as well as increased opportunities for recreation. Non-monetized benefits will include prevention of further stresses on biodiversity and ecosystems. Though the magnitude of benefits is not calculable, *Table 6-6* presents a summary of potential benefits resulting from 2013 VGP revisions.

Table 6-6. Benefits of Reducing Pollutants Found in Vessel Discharges.

Type of Benefit	ANS	Nutrients	Pathogens	Oil & Grease	Metals	Other Toxics	Other Non-Toxics
Human Health	X	X	X	X	X	X	
Biodiversity	X	X		X	X	X	X
Ecosystem Function	X	X		X	X	X	X
Improved Fishery Conditions	X	X	X		X	X	X
Increased Recreational Opportunities	X	X	X			X	

Source: Battelle (2007)

a. Other Permit requirements that could not be firmly linked to one of these six categories of pollutants are excluded from the table

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APPENDIX A – BILGEWATER TREATMENT SYSTEM COST ESTIMATES

Table A-1. Bilgewater Treatment System Cost Estimates - Low Flow (1 m^3/day)

Bilgewater Treatment System	System A	System B	System D	System E[b]	System F	System G	System H[f]	System I	System J
Purchase cost	$13,350	$2,024/yr[a]	$21,270	$95,000	$38,400	$100,380	$16,300[g]	$5,000[j]	$10,000[j]
Replacement media & parts	$2,090/yr	(see footnote a)	$1,780/yr	$143/yr[c]	$1,550/yr[d]	$1,095/yr[e]	(see footnote h)	(see footnote h)	$1,814/yr[k]
Labor	$5,840-9,125/yr	$7,990/yr	$5,840-9,125/yr	$5,840-9,125/yr	$5,840-9,125/yr	$5,840-9,125/yr	$5,840-9,125/yr	$5,840-9,125/yr	$5,840-9,125/yr
Residual Disposal[l]	$127-253/yr	$31-63/yr	$4,820-9,640/yr	$23-46/yr	$127-253/yr	$130-260/yr	(see footnote i)	(see footnote i)	(see footnote i)
Total annual cost	**$9,320-12,730/yr**	**$10,050-10,080/yr**	**$14,440-22,550/yr**	**$14,970-18,280/yr**	**$11,140-14,550/yr**	**$16,540-19,960/yr**	**$7,379-10,664/yr**	**$6,312-9,597/yr**	**$8,598-11,883/yr**
Cost per 1,000 gallons treated	**$97-132**	**$104-105**	**$150-234**	**$155-190**	**$116-151**	**$172-207**	**$77-111**	**$66-100**	**$89-123**

Note: Total annual costs were amortized over 20 years using a 7% discount rate.

a Cost of operating equipment includes capital outlay, consumables (nutrient and pH chemicals, starter/booster microbial cultures, and chemical analysis supplies), spare parts, electrical usage, labor, disposal quantities and cost.

b This system does not use chemicals or absorption filters to clean the water from oil and particles, only Gravitational-force, then uses a filter to polish to below 5ppm. The cost of the separator is the same for the 2.5 m3/hr and 5 m3/hr systems. The cost of the filter is $925 and is replaced, at most, every 100 days.

c Replacement media and parts costs include replacement of O-ring seals and gaskets every 83 days of operation, and replacement of bearings every 333 days. The operating cost of this system is only the service required for the centrifugal separator -- every 2,000 running hours an Intermediate Service is made and every 8,000 a Major Service is made.

d Maintenance only includes replacing the filters. Replacement costs have three components: 1. Coalescer Element filter, replaced annually on new ships (bi-annually on older ships); 2. Advance Granular Media filter, usually replaced annually; 3. Gasket set, also replaced annually.

e Operating costs includes replacement parts, chemicals, and media. Filter media and Granular Activated Carbon (GAC) are steam regenerated and require annual replacement, at most.

f This system comes equipped with a fluorescent detection OCM.

g This system treats 2.4 m3/day, which is the lowest flow rate treated by this manufacturer's OWS systems.

h No replacement media and parts costs were provided.

i Abt Associates was unable to estimate the residual disposal cost.

j This system treats 10.9 m3/day, which is the lowest flow rate treated by manufacturer's OWS systems.

k Includes replacement cost and labor of Stage II filter every 14 months. Filter costs $2,000 and requires two hours of labor to replace.

l Abt Associates was unable to verify estimates of the residual disposal cost reported in GLEC (2011).

Table A-2 Bilgewater Treatment System Cost Estimates - High Flow (1 m^3/hr)

Bilgewater Treatment System	System A	System B	System D	System E[b]	System F	System G	System H[f]	System I	System J
Purchase cost	$13,350	$7,025/yr [a]	$21,270	$95,000	$38,400	$100,380	$19,500	$14,000[i]	$22,000[i]
Replacement media & parts	$27,190/yr	(see footnote a)	$2,200/yr	$3,420/yr[c]	$6,166/yr[d]	$26,280/yr[e]	(see footnote g)	(see footnote g)	$1,814/yr[j]
Labor	$23,360-36,500/yr	$49,400/yr	$23,360-36,500/yr	$23,360-36,500/yr	$23,360-36,500/yr	$23,360-36,500/yr	$23,360-36,500/yr	$23,360-36,500/yr	$23,360-36,500/yr
Residual Disposal[l]	$1,640-3,270/yr	$750-1,500/yr	$115,630-231,260/yr	$550-1,100/yr	$1,140-2,270/yr	$860-1,710/yr	(see footnote h)	(see footnote h)	(see footnote h)
Total annual cost	**$53,450-68,220/yr**	**$57,190-57,940/yr**	**$143,200-271,970/yr**	**$36,300-49,980/yr**	**$34,290-48,5600/yr**	**$59,970-73,970/yr**	**$25,201-38,341/yr**	**$24,682-37,822/yr**	**$27,251-40,391/yr**
Cost per 1,000 gallons treated	**$23-30**	**$25**	**$62-118**	**$16-22**	**$15-21**	**$26-32**	**$11-17**	**$11-16**	**$12-17**

Note: Total annual costs were amortized over 20 years using a 7% discount rate.

a Cost of operating equipment includes capital outlay, consumables (nutrient and pH chemicals, starter/booster microbial cultures, and chemical analysis supplies), spare parts, electrical usage, labor, disposal quantities and cost.

b This system does not use chemicals or absorption filters to clean the water from oil and particles, only Gravitational-force, then uses a filter to polish to below 5ppm. The cost is the same for the the 2.5 m^3/hr and 5 m^3/hr systems.

c Replacement media and parts costs include replacement of O-ring seals and gaskets every 83 days of operation, and replacement of bearings every 333 days. The operating cost of this system is only the service required for the centrifugal separator -- every 2,000 running hours an Intermediate Service is made and every 8,000 a Major Service is made.

d Maintenance only includes replacing the filters. Replacement costs have three components: 1. Coalescer Element filter, replaced annually on new ships (bi-annually on older ships); 2. Advance Granular Media filter, usually replaced annually; 3. Gasket set, also replaced annually.

e Operating costs includes replacement parts, chemicals, and media. Filter media and Granular Activated Carbon (GAC) are steam regenerated and require annual replacement, at most.

f This system comes equipped with a fluorescent detection OCM.

g No replacement media and parts costs were provided.

h Unable to verify the residual disposal cost.

i This system treats 5.68 m^3/hr, which is the flow rate closest to 1m^3/hr that this company's OWS systems treat.

j Includes replacement cost and labor of Stage II filter every 14 months. Filter costs $2,000 and requires two hours of labor to replace.

l Abt Associates was unable to verify estimates of the residual disposal cost reported in GLEC (2011).